PROCESS MAPPING IN NEW PRODUCT DEVELOPMENT FOR ENVIRONMENTAL IMPACT REDUCTION IN SMALL AND MEDIUM MANUFACTURING ENTERPRISES

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ABSTRACT

Environmental impact reduction (EIR) in Product Development processes, can involve numerous elements and activities. In relation to business objectives, the strategic review and integration of environmental impact reduction should be considered a best practice development opportunity and a contribution towards longer term sustainability. It should be recognised that environmental impact reduction requirements are often complex and challenging for businesses to implement, especially for those companies lacking the knowledge and internal resources to address these activities. This has been found to be the case particularly with Small and Medium Enterprises (SMEs) where flexibility towards new approaches can be strategically more problematic, due to the limitations of available capital and resource.

After a combination of literature review, industrial collaboration and data collection from within the manufacturing logistics systems of packaging for SME products, an opportunity was identified to develop a contemporary framework to integrate key critical environmental impact reductive activities, within adjoining New Product Development (NPD) activity. Engaging key activities of environmental impact reduction seamlessly into standardised NPD though a visual mapping process, can promote changes in current behaviour towards best practice development opportunities concerning environmental impact reduction. The contribution to new knowledge from this programme of research has been the development of an investigative framework for visually mapping the product development processes which provides manufacturing SMEs with an approach to capturing ‘visual snapshots’ of their current engagement within environmental impact reductive activities. This visual mapping process addresses a range of company sizes and organisational behaviours to provide specific feedback and inform best practices for more sustainable NPD.

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Thank you.

AUTHOR'S DECLARATION

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work.

I confirm that no part of the material offered in this thesis has previously been submitted by me for a degree in this or any other university. This thesis presents the author's own work, except where appropriately acknowledged citations are given. Where material has been generated through joint work, my independent contribution has been clearly indicated.

I declare that the Word Count of this Thesis is: **61'430**

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Glossary of Abbreviated Terms

SME: Small and Medium Enterprises.

NPD: New Product Development.

EIR: Environmental Impact Reduction.

PROR: Producer Responsibility Obligations and Regulations.

PER: Packaging Essential Requirements.

EMAS: Environmental Management and Audit Scheme.

EU: European Union.

EMS: Environmental Management System.

BBP: Better Business Pack.

CAD: Computer Aided Design.

ISO: International Standards Organisation.

PCR: Post Consumer Re-grind.

PIR: Post Industrial Re-grind.

BIO: Biologically Degradable.

PLA: Polylactic Acid.

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1: INTRODUCTION

1.1 Background

Scientists are in ever increasing agreement that society and industry is currently on a long-term unsustainable course of action at the current levels of product production and consumer consumption (Hallstedt, 2009). Dwindling natural resources puts great pressure on industry to engage with more innovative practices, which cater for an increasing dependency from a growing population, while still supporting economic growth (Rosen, 2009; Liu, 2009; Kuhlman, 2010).

This research was therefore initiated to investigate how environmental regulations impact upon product producing UK Small to Medium Enterprises (SMEs), and in what ways environmental concerns, if any, influence current practices for New Product Development (NPD). A large majority of environmental regulations revolve around the management of product packaging creation and its subsequent waste management. This is due to the abundance of packaging used to house and ship products for consumer purchase through the various logistical chains to the customer. Eventually, all packaging becomes redundant, which resultantly contributes huge volumes of used and surplus packaging to either; energy recovery, recycling or landfill. Therefore, due to the quantities of raw material resources invested within these activities, it is imperative that packaging and environmental best practice becomes forethought rather than an afterthought for the protection and delivery of consumer products.

Businesses that are classed as SMEs make up to 99.8% of the total UK economy, making them an overwhelming majority and significant cause for concern where best practice towards environmental impact reduction (EIR) is a low priority. Environmental impact reductive practices are those which consider a responsible attitude towards the use of materials and resources, and take steps to improve the efficiencies of outputs in parallel with company operations. Whereas larger organisations may integrate EIR as part of company strategic objectives in line with

their regulatory obligations, smaller organisations such as SMEs, do not appreciate the intrinsic value of these investments. Due to overly complicated environmental literature; intricate compliance requirements; and infrequent / non-rigorous compliance inspections; a significant proportion of SMEs go unregulated, uneducated and misinformed (Wilson 2010). Additionally, a significant majority of SMEs are currently not required to improve their practices under government law, due to their size classification being less indicative of environmental threat as oppose to that of larger organisations. Therefore, the levels of environmental impact contributed due to non-compliance within this area are unregulated and uncontrolled.

With EIR for sustainable NPD, this presents a problematic scenario in that the largest enterprise sector for the UK economy are far from optimised due to lack of awareness and responsibility (Wilson 2010). Since the majority of impacts of product packaging life cycles derive at the stage of design and specification, such a grey area and lack of responsible practice within SME NPD could present far reaching environmental consequences. By nature, product development is a rigorously complex and influential activity where the microcosms of decision making at the design and specification stages are responsible for initiating up to 80% of all environmental impacts during a products life-cycle (Ashley, 1993; Ellram et al, 2008). This raises concern at an SME level, as SMEs have no one fixed mode of operation for NPD due to a lack of overall knowledge and influence within current supply chain systems.

Decisions at the design stage have to consider not only the company's strategic objectives and environmental concerns, but bear in mind the interests of company stakeholders; availability of resources; fit-for-purpose design; and technical feasibility. All these elements are subsequently played out within a complex supply chain that is intricately regulated by government standards and obligations for producer responsibility (Envirowise 2008). Where the value of EIR is unclear to SMEs, a

significant challenge is presented in providing a justifiable argument to engage with EIR activities. Moreover, SMEs are typically short of time and staffing resource to engage with additional activities which are not deemed as essential for the day to day running of the business. This means that any additional efforts placed into activities outside of those deemed essential, must be backed up with a solid argument as to how they will directly benefit the business in both the short-term and the long-term aspects. Where a lack in education, implementation and awareness of EIR activities are present with SMEs, a challenge is presented in how to address the behavioural routines of SMEs to encourage engagement with EIR as part of company practices.

This research therefore aims to enhance the practices of long term sustainable product development in a way which guides SMEs in navigating EIR alternatives through the design phases of NPD, and subsequent supply chain logistics. To move away from the laborious formats of text heavy environmental documentation, to an approach using visual process mapping techniques, to create synergy between EIR activities and standardised NPD procedures. Using a visual language through process mapping, provides a novel method in engaging with complex environmental data in a way which becomes more accessible and tangible to the user. Using visual methods enables the user to engage with the data to create enable greater contextualisation as to the relevance of EIR against current practices and the potential benefits for implementation.

Therefore, through enhancing the contextualisation of benefit for EIR activities in line with NPD procedures, decision-making at a management level can be more justifiably orientated towards inclusion of sustainable product development activities. If EIR within the SME sector is to be improved, decision making at the design stage must be optimised so that when potentially unregulated packaging enters the supply chain it creates less impact during its life cycle.

1.2 Project Aims

This research aims to test the principle of using visual language and process mapping techniques to reduce the overall complexity of environmental requirements for SME product producers. This will result in an overall framework which can impart and stimulate improved decision-making through a prompting method within NPD, which encourages communication and discussion in relation to EIR activities.

This method will not only visually reduce the complexity of environmental data, but demonstrate in parallel actionable steps for implementation and the subsequent benefits from use in line with NPD procedures.

1.3 Project Objectives

From the research aim above, a number of Research Objectives were formulated. These were:

RO1. To identify the following from academic literature:

- The main areas of EIR activity and the key factors for concern.
- Difficulties with which SMEs face when dealing with EIR and packaging.
- The boundaries of regulations, and their implementation with SMEs.
- The current systems of NPD management for SMEs with EIR.

RO2. To develop a suitable research methodology that enables the identification of key themes of best practice for SME EIR, while developing suitable mapping procedure for visually representing EIR activities.

RO3. To develop a concept / process mapping technique which represents SME packaging design and delivery processes. This is to be done concurrently with

the identification key research themes for SME EIR practices while working with a panel of industrial experts.

RO4. To use the RO3 developed concept map, in combination with the key research themes, to define critical areas for inclusion within a questionnaire for industrial participants.

RO5. To use a panel of external industrial experts via the Delphi method to gain the broadest range of critique when piloting the industrial questionnaire, while concurrently obtaining suitable SME and packaging supply contacts with which to post the industrial questionnaire once refined.

RO6. To further refine the concept / process mapping technique by using the method to evaluate industrial questionnaire responses. This will be for the further refinement of process mapping technique, and further refinement towards key themes of EIR best practice to be included within the final design.

RO7. To use further literature review to explore in greater detail; the chosen key themes of EIR best practice to be included within the final design; an informed but generic NPD procedure with which to integrate EIR key themes; to allocate a stepped approach to each EIR key theme and subsequent benefits.

RO8. To use process mapping narrative and visual language to create synthesis and flow within the final design, that serves to prompt the user to engage with EIR activities enabling them to draw snapshot conclusions through self-evaluation.

RO9. To use a panel of industrial experts via the Delphi method to evaluate the final design and identify further research opportunities within this area, to gain the broadest range of professional consensus

1.4 Research Contribution Claims

The contributions to new knowledge of this research are:

1. *Mapping industrial process as a research tool.*
2. *Process Mapping EIR into NPD.*
3. *Reduction in complexity of environmental data for SMEs.*
4. *Tipping point of SME best practice for EIR in SME sizes.*

1.5 Thesis Structure

Chapter 1: This chapter has provided an introduction to the research including the motivation for the study, some background in relation to SMEs and the problems which they face to adopting environmental practices, and initial research questions.

Chapter 2: Provides a comprehensive review of the academic literature covering: SMEs and environmental best practices; management structures for SMEs; regulation procedures and frameworks for sustainable NPD procedure.

Chapter 3: Choices of potential research methods are discussed with a for-and-against argument in relation to the eventual chosen method to investigate the SME manufacturing sector and analyse the data gathered.

Chapter 4: This describes the steps taken to filter EIR key themes of best practice into the industrial questionnaire. Pilot tests for the industrial questionnaire are run with the Delphi method's panel evaluators before dispatch.

Chapter 5: This covers the processes which were undertaken to analyse the environmental data returned from the industrial questionnaire, this will include the steps which were taken to use process mapping narrative to identify key themes.

Chapter 6: This covers the refinements which were undertaken to build the final process mapping design to encourage SME EIR practices within industry. This will include further literature review to inform all areas contained within the final design.

Chapter 7: This covers the data analysis from the final process mapping evaluation design for SME EIR with the Delphi method's expert panel, including a report on the findings which were returned in relation to validating the original research aims.

Chapter 8: A summary of the limitations experienced throughout this programme of research, while additionally discussing the potential for future research opportunities to future process mapping use with SME EIR.

Chapter 9: Conclusions from the current research programme discussed including the contributions to new knowledge.

2: LITERATURE REVIEW

2.1 Introduction

This chapter will introduce the key factors for small to medium enterprise businesses (SMEs), when engaging with practices towards environmental impact reductive activities. This will include discussion around the systems at a macro level which facilitate new product development (NPD) and the importance of environmental impact reduction (EIR) within this activity.

Further focus will include the internal management of NPD and attention will be drawn to external influences, such as regulatory requirements and working with supply chain partners. Successful implementation of EIR activities in line with NPD relies on the SMEs ability to manage these factors in parallel. Therefore, this chapter will highlight the current issues SME face when implementing EIR activities and describe the gap in knowledge for SMEs adapting to more sustainable long-term product developments.

2.1 The Process and Importance of New Product Development (NPD)

NPD is an industry term used in reference to the decision making process of bringing products and services from initial ideation, to the point of manufacture and subsequent market launch (Owens, 2001). This process incorporates a wide range of explorative phases which are backed up against rigorous decision making criteria. As a combination, these activities aim to align the potential product offering against the perceived market requirements.

The practice of launching a new product is one of the most critical and professionally challenging tasks a product manager will face (Tzokas et al, 2004) due to the numerous factors which must be managed throughout a number of successive development phases within NPD. In addition, the low-cost competition of overseas

manufacturing companies' puts increasing pressure upon UK firms to contend for business in terms of cost, quality and timelines within a tough economic climate (Millward & Lewis, 2005). As a result, product manufacturing companies have long accepted that they must strive to improve their performances, where results are competitive on time and at the right price, (Filson, 2010; Fujimoto, 1990).

To generate competitive advantage, NPD provides steps to innovation in line with manufacturing, to encourage and structure new directions, (Woodcock et al, 2000). NPD is typically practiced in a linear fashion, as shown in Ulrich and Eppinger's (2004) model in figure 1 below, and guides senior management through the various development stages required. Emphasis for success within NPD activities are usually placed upon systems which can simultaneously provide: quality, variety, frequency, speed, response and customisation throughout the NPD process, (Bessant, 1997; Cooper, 1994; Coyne, 1996; Johne and Snelson, 1988; Rothwell, 1992; Maidique, 1985). The path to successful NPD implementation can therefore be complex due to the number of factors which need to be managed and assessments which take place between each phase of development.

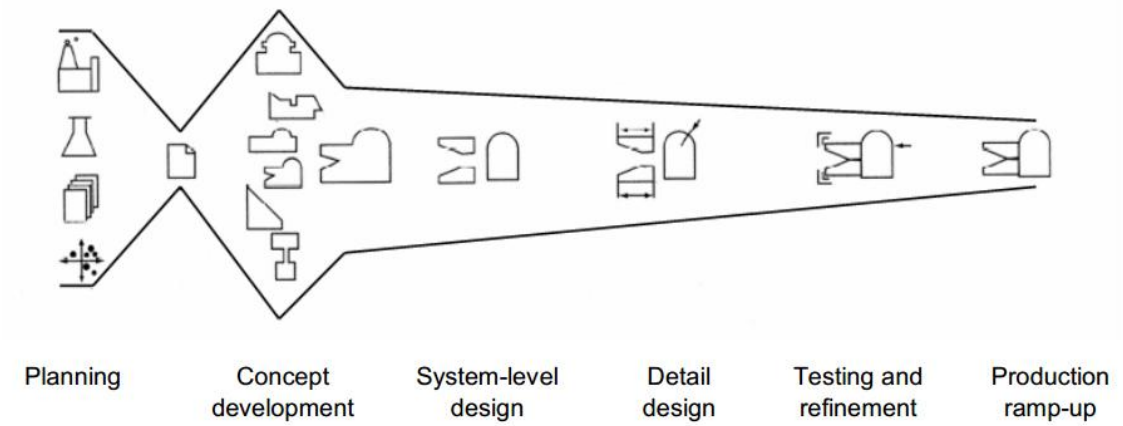


Figure 1: The Ulrich and Eppinger Model of the NPD Process (2004)

Studies have shown that NPD activity when practiced successfully can generate higher financial returns than any other type of similar investment, which involves the same

levels of time and resource inputs, (Kahn et al. 2005). However, effective implementation of NPD essentially hinges around the firm's ability to manage effective cross-functional team working; manage individual project stage requirements; and support systems which enable learning and development within the organisation (Bessant, 1997). Further requirements which manufacturing organisations need to master for effective NPD implementation generally include the assessment of the current market needs; contingency with planning in regards to the needs of the consumer; demonstrating technical superiority to bring to fruition the required product; manage budget considerations in line with product launch deadlines; and then outperforming the competition to provide competitive advantage, (Tzokas et al, 2004; Calantone & Cooper, 1979; Cooper & Kleinschmidt, 1987; Griffin, 1996; Hultink, Griffin, Hart, & Robbenm, 1997).

In combination with managing these factors there are iterative development stages with pre-defined ‘go and no-go’ critical decision making points throughout the NPD process for continual evaluation, Millward & Lewis, (2005). These points are referred to as 'Gates'.

2.1.1 Evaluation Gates as Checkpoints During Product Development

NPD involves numerous development stages which require iterations of investigation and refinement for the potential product idea. These stages tend to begin broadly by focusing out to explore idea potential and practicality of concept, to ultimately focus in on the refined details where key success criteria are addressed as part of the process. As organisational knowledge improves though this process of investigation and development, focus towards the most appropriate product offering is realised in parallel.

These stages of development are interpolated by a number of evaluative phases, which are more commonly referred to as 'Gates' (Tzokas et al, 2004; Cooper, 1990), or 'convergent points', Hart & Baker (1994). These evaluation gates provide managers with a check point for 'go and no-go' decision making during the development process, which will either, progress the project to the next stage; request further development; or stop the project entirely. An example of these interpolative gates within NPD can be observed within the Tzokas et al, (2003) model in Figure 2.

Evaluation gates provide management with a failsafe mechanism for NPD. This is essential as the project progression takes place and requires more serious investments; therefore it is critical to be able to check current progress against essential company criteria. In support of this, Tzokas et al, (2004), report that:

> *"Within each evaluation gate, management uses pre-specified criteria to assess whether different tasks have been performed efficiently and effectively. These criteria act as 'guideposts' against which the performance of the NPD effort can be evaluated and adjustments made, if necessary." Tzokas et al, (2004), p.619.*

This approach of using gates within stages of NPD enables management to reduce uncertainty and identify areas where additional attention and resources are needed, in line with the companies' objectives and competencies through each development phase. The project management process of using stage and gate NPD has been seen by many in both academia and industry, as a major resource for increased sales and improved profit margins within manufacturing, (Millward & Lewis, 2005; Jennings & Beaver, 1995), and that the use of a gated multi-stage development process is now being considered as a 'best practice' across much of today's industry.

Using a stage and gate system in NPD therefore provides an organisational framework with common criteria for go, or no-go, decision making structures at each stage of product development.

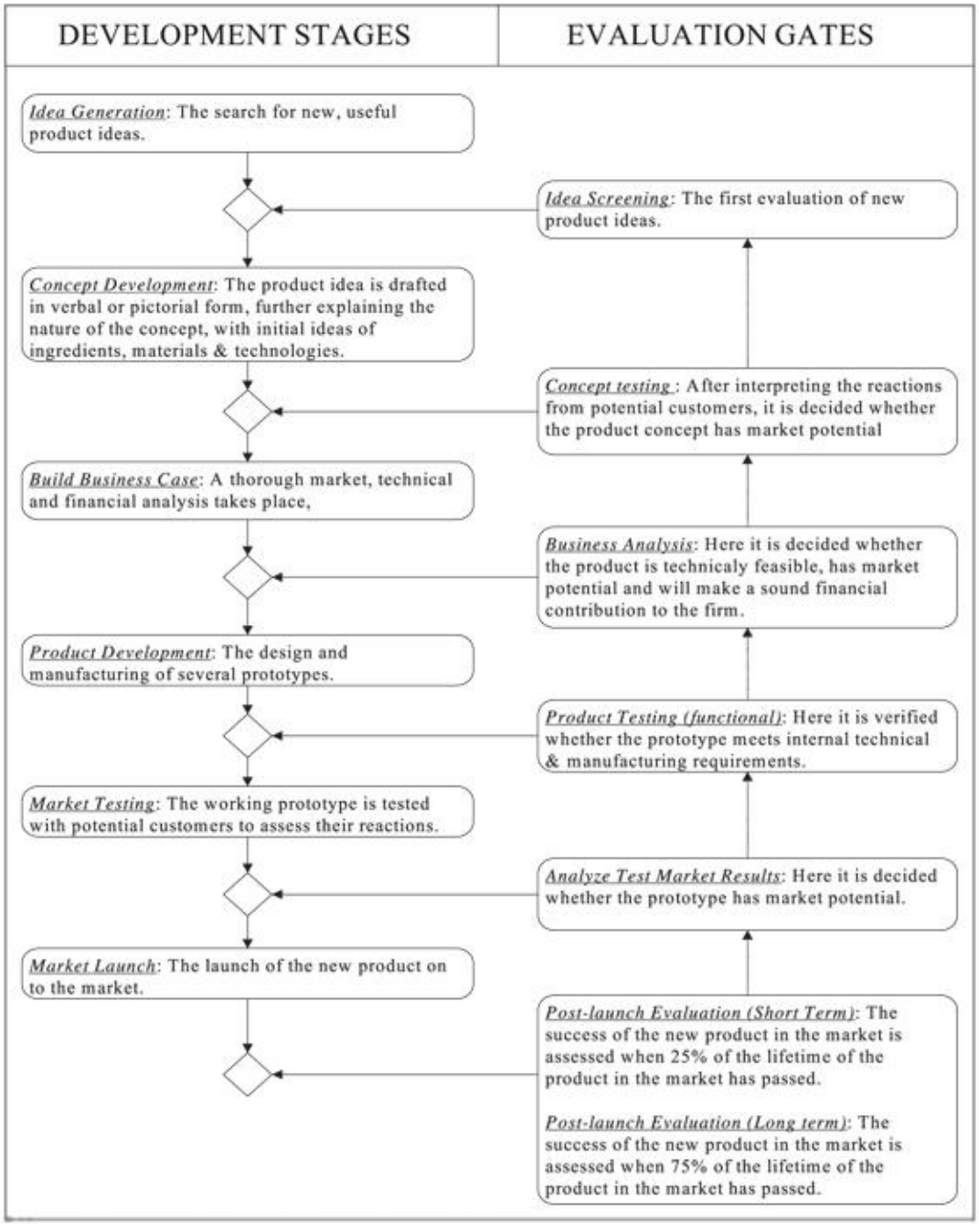


Figure 2: The Tzokas, et.al model of the Stage and Gate Process (2003)

This can then enable the assignment of appropriately skilled team members where relevant during each phase of NPD (Bessant, 1997).

As NPD activities involve: technical, financial and market based criteria, (Cooper & de Brentani, 1984; Craig & Hart, 1992; Hart, 1993), it is important to highlight that the evaluative criteria used within the NPD gates, also demonstrates these dimensions, (Tzokas et al, 2004). Typical gate criteria used within standardised NPD exists to critique NPD activity, and tends to encompass the following:

- *Gate 1, Idea Screening Gate:* Here, the technical feasibility and uniqueness of a product idea are considered alongside market potential and customer acceptance. Management at this stage may want to ensure that only the right ideas are chosen to take forwards for further exploration, although 'wild' ideas can often be encouraged at this development stage for radical innovation, it is essential to strike a balance between desirable and feasible. It is still difficult to have precise information here about technical requirement and market response, so intuition and experience is usually a driver for progression.

- *Gate 2, Concept Testing Gate:* Verbal and pictorial forms of the product idea and presented here to assess market potentials. Customer acceptance predictions and technical feasibilities are evaluated to consider progressing onto the business analysis of the product concept. Detailed descriptions of the product idea at this stage allow management to make assessments in regards to technical requirements.

- *Gate 3, Business Analysis Gate:* At this stage the product idea has undergone a corporate wide analysis with regards to technical, financial and marketing prospects. At this stage, management will decide whether to continue development, or search for new ideas. This stage is critical, as further investments of time will require substantial commitment of resource.

Considerations at this stage tend to reflect the financial issues regarding the concept, rather than its technical feasibility.

- *Gate 4, Product Development & Testing Gate:* Management will ascertain if the product is being developed in regards to specifications which have been set in prior stages. Most criteria here revolve around the importance of product quality, performance and technical feasibility.

- *Gate 5, Market Test Gate:* Prototypes are constructed and made available to the potential customer base for evaluation purposes. Here it is critical to assess customer reactions to the product and the overall performance in relation to expectations.

- *Gate 6, Post Launch Gate:* Managers generally assess whether the product is performing according to expectations within the marketplace. This is a critical process in order to detect adverse issues which may affect future product lines or company brand and image as a whole. (Tzokas et al, 2004)

2.2 Management and Best Practices of New Product Development

Even though NPD stage and gate procedures potentially offer a formalised procedure, successful implementation still requires a significant level of competency and in-house experience. Bessant, (1997), highlights that any new streams of product development require more than just an awareness of the procedures and associated issues. Specialised skills, knowledge, processes, mind sets, problem solving mechanisms and management philosophies are also required for successful implementation of NPD procedures.

Relative behaviours within organisational performances and the way in which procedures are embedded at a management level, are of growing interest to those in the study of refining the most appropriate innovation techniques, (Cooper, 1994; Pentland and Rueter, 1994). Some of the major differences which affect the current levels of innovation demonstrated by organisations when planning for NPD, originate from firm specific routines and management's ability to observe and react accordingly, (Pavitt, 1991). Bessant, (1997) comments that routines in organisational behaviour, which for example revolve around the collection and communication of information; working effectively in teams; and day to day project management, are largely autonomous within organisations and tend to be fixed due to a learning and reinforcement process which is fostered on a firm specific basis.

Bessant, (1997), continues that company specific routines are not easy to acquire or to manipulate as they are the result of a learning process which happens over time through various experiments, experiences, failures and successes. Therefore, company specific learning's are not easily transferable between differing firm management structures, as the learning's originate over time / rehearsal, where procedures become firm specific.

For this reason, what works well for one firm, cannot simply be copied by another to expect the same results, due to each organisation operating with embedded personal routines and relative practices. This process of experiential learning is vital if new approaches and changes are to become a part of existing company routines and NPD practice, therefore to encourage behaviour change it is essential to consider that:

> *"There is no substitute for individual learning and development of appropriate responses. Implementing new or improved NPD approaches requires that we strengthen our understanding of the processes which support the articulation,*

development, introduction and consolidation of suitable routines." Bessant, (1997), p.192.

Comprehension of such routines can prove to be a difficult task, due to the variety of practices which are currently underfoot. For example, routines within small to medium enterprises, (SMEs), will tend to vary within both workforce and managerial contexts due to the availability of staffing resources and experience. This indifference will ultimately affect the overall consistency of best practice routines for standardised NPD within the UK manufacturing sector. Millward & Lewis, (2005), comment that resource constrained SME companies treated NPD activities as simply the 'front end' of their overall development process, rather than implementing NPD criteria throughout. Therefore, within SMEs, the strategic importance and potential benefit of a more formalised NPD process was generally overlooked.

According to Millward & Lewis, (2005), shortfalls within this area are mainly due to the prioritisations of time and cost being placed above all other commercial and operational matters, making poor NPD implementation a common occurrence within SMEs. This lack of formalised procedure presents a situation where SME management structures may begin to benefit from a more systematic approach to NPD to change behaviour with routines which are not necessarily driven around the factors of time and cost. Prompting engagement with additional practices outside of routine behaviour may start to include creative procedures such as formal design training and / or; the adoption of simple design tools for more comprehensive product design specifications, to enable the identification of new avenues of research potential.

Millward & Lewis, (2005) argue that improved structures are required to help SME managers make more informed judgements about NPD processes, which in turn can assist the firm to break out of specific routines. Lewis, (2005) continues to comment

that management structures within SME companies need to evolve from the current status quo, to facilitate the development of a culture which is more receptive and encouraging, towards organisational and operational changes.

This is also supported by (Woodcock et al, 2000), who comments that SME's face a dilemma in NPD:

> *"While they recognise the need for NPD, attention to work in this area is frequently driven out by other immediate priorities. Where NPD activities are undertaken, they have to be achieved with limited resources. Ideally, this should promote the use of efficient and effective systems in order to maximise the benefits to be potentially obtained. Regrettably, this does not appear to be the case in practice." Woodcock et al, (2000), p.220*

A review of case study material by Millward & Lewis, (2005), p.338, identified three generic managerial issues within SME firms, which can impinge on their new product development strategies:

1. The influence of a dominant owner / manager;
2. A focus on time and cost ahead of other key factors; and,
3. The failure to understand the importance of correct product design practices within NPD.

According to Millward & Lewis, (2005), these difficulties may typically be hard to change where routines have set in. Within SME management structures, such behaviours can contribute to a lack of understanding for contemporary NPD practices, backed up with a serious lack of determination at a senior level, to bring about change, (Woodcock et al, 2000). One reason for this lack of determination, may be due to an SMEs deficiencies in market and competitor analysis, which leaves them with an over

optimistic view of their own performance. Additionally, according to Woodcock et al, (2000), in order for SMEs to facilitate change, they need to critically, continuously and systematically measure their own performances. Unfortunately, they don't, due to the potential and perceived costs involved and a lack of awareness towards the value of such information and what to do with it.

(Woodcock et al, 2000), found that SME firms simply did not have the cultures which supported this data collection, and that no systems existed for SMEs which enabled the recording of their performance during a typical NPD process. Based on the habit forming nature of this manufacturing sector, it is therefore unlikely that small firms will change their routines to enable the recording of data for self assessment, unless they can recognise the potential performance improvements which can be gained as a direct result of this activity.

Filson, (2010) and Driva, (2001) comment that for things to move forwards for the SME sector, a gradual, and step-by-step change to practices is required for management. Some of the criteria for such a change would need to include:

- recognition of shortcomings within existing practices,
- the development and implementation of improved communication mechanisms to discuss shortcomings,
- improved ownership and implementation of formalised product development procedures within the company,
- changes to long-established practices and ways of working, which challenge the status quo,
- the involvement of key departments and functions throughout the product development cycle, which each play specific roles,

- an awareness of the company's product strategy, in line with NPD activity.

Filson, (2010); Driva, (2001), continue that in order for a change to occur within NPD managements, there needs to be a recognition at all levels within the organisation that existing methods and approaches are no longer delivering the results which they need. If NPD efficiencies are to be improved though new approaches, the current culture has to be challenged and move away from its former ways of working.

Where management of SME NPD is concerned, Tzokas et al, (2004), comments that success rates depend on the mastering of planning, development, deployment, evaluation and control of the necessary competencies required for individual success. For success to be realised, these factors must be applied throughout the entirety of the firms development process, i.e., from the initial generation of a new idea to eventual product launch in a way which utilises the core competencies of the firm. Core competencies should be in line with, and reflect the strategic objectives of the firm.

Bessant, (1997), comments that a solid understanding of the company's competitive strengths and strategic focus enables effective NDP to be an implementation process in line with organisational core values, as oppose to an isolated activity managed in an ad-hoc manner. With a more formalised approach, the NPD process can then be guided by the firms 'core values' to create the new product 'strategy'. This combination of planning and alignment of strategic objectives alongside NPD means that decision making is structured, so that the firm can make the best use of its internal competencies, (Tzokas et al, 2004).

According to Bessant, (1997), this structure is the key to success, being that if those who are involved, affirm, understand and support the NPD process, while understanding its benefits and the relevance to the firm, they will make it work;

"Even the world's most elegant NPD system will fail if understanding is lacking, where there is no 'buy-in', or support is absent." Bessant, (1997), p.196

It is therefore apparent that well managed NPD can add value and focus to the process of developing new product and service fruitions for organisations that can formalise and structure their own procedures. Much like practicing innovation techniques, or creativity, it would appear that successful implementation of NPD becomes a practiced art, which is learnt over time and perfected in line with organisational capacity and requirements.

Therefore, there is much room for improvement within SME management for the adoption of more structured procedures, where moving away from routines has been historically difficult without the identification of a convincing argument to do so.

2.3 Small and Medium Enterprises (SME's) and the Environment

Small to medium sized enterprises play a central role and provide an overwhelming contribution to the UK and European Economies, making up the majority share of privately owned businesses throughout, *(Hillary, 200*3). They are a major source of Entrepreneurial skill and total around 99.7% of all UK businesses.

In 1998 there were 3.7 million businesses within the UK, of which 99% were SME's employing less than 50 people, and only 25,000 were medium sized organisations employing between 50 and 249 members of staff, *(DTI, 1991).* The size classifications of SME's are quite diverse, with considerable jumps in employee numbers grouped into each particular division. The biggest of these employee size gaps happens between the small; 10-50 employees, and the medium; 50-250 employees size sector.

The current classifications of SME sized companies within the UK currently falls into three main group categories:

Size:	**Headcount:**	**Annual Turnover:**	**Annual Balance:**
Micro:	< 10	< Undefined	< Undefined
Small:	< 50	< 6.5 Million	< 3.26 Million
Medium:	< 250	< 25.9 million	< 12.9 million

(European Commission, 2006).

With such diversity within the categorisations in employee size, for example: within the 'medium' classification ranging from 50-250 employees, it is difficult to be able to generalise towards NPD or environmental practices, where such variance of staff resource is so clearly apparent. For example, the environmental responsibilities facing the sole trader will have little similarity to those of a much larger firm which employs up to 250 members of staff, but yet, while being heterogeneous in nature, they are grouped within an SME sector clarification, *(Hillary, 2003).*

The diversity which is presented here, according to Hillary, (2003) creates unique complications for study within the sector, as conclusions drawn from investigations are to some extent not just comparing apples and pears, but comparing the whole fruit bowl collectively. As a result of this diversity, current toolkits and practices suitable for one sized organization may not effectively work for another. For reasons of such variation it would appear difficult to be able to assign any particular operational procedure to SME's holistically. With this variance in size between 10 and 250 employees, there is simply too much differentiation to assume that all internal practices are equally competent for the uptake and implementation of new systems.

2.3.1 Small and Medium Enterprises, Best Practice and Packaging

Every product which is released on the market utilises packaging in one form or another. The essential role of product packaging is to protect the inner contents from the outside influences and potential damage; to contain the intended product for consumer delivery; and to provide consumers with essential information in regards to the contents, (Marsh & Bugusu, 2007).

Verghese and Lewis, (2007) and Saphire (1994), classify packaging as fitting into the following three major categories:

- Primary packaging: primary packaging refers to consumer or retail packaging and is the basic package which is used to contain the product through all logistical systems until the consumer is reached. Therefore this packaging also plays an important marketing role in attracting the customer's attention to buy the product to stimulate product sales. This primary packaging is generally disposed of by whatever means the consumer feels necessary.

- Secondary packaging: secondary packaging refers to the additional packaging which is essentially used to facilitate self-service sales, contain large volumes of the product for presentation and further advertising such as shelf stand systems, and to prevent theft. This secondary packaging is generally thrown away once the products contained have been removed.

- Tertiary packaging: Tertiary packaging refers to the transportation, distribution or logistical packaging required to ship goods from the point of origin to their destination. Tertiary packaging consists of boxes, crates, palettes, void fill packaging or cushioning material. The emphasis of Tertiary packaging is on protection and functional performance during shipping. Unless specified and designed for reuse and return, tertiary packaging is generally thrown away.

According to Verghese and Lewis, (2007), due to the volume of packaging required for the delivery of the products to the consumer, packaging will create significant impacts within product supply chains. Therefore, packaging specifications will generally affect the efficiency of distribution; the degree of product spoilage and damage during transit; and the level of environmental impact from product waste through disposal.

The excessive volumes of packaging required to perform these functions therefore have significant environmental impacts which are not sustainable in the long term. The type of environmental impacts which are to be expected from excessive packaging use will include: consumption of non-renewable resources; generation of air emissions from production; transportation impacts throughout the supply chain logistics; and the inevitable requirements of solid waste disposal, moreover sent to landfill, (James et al. 2005).

The relative contribution to this environmental impact from SMEs is additionally considerable, given that SMEs dominate the manufacturing sectors in areas such as: metals, printing, textiles, food, and consumer products, all of which require packaging in one form or another. Therefore, a significant amount of commercial and industrial waste is produced from these SMEs during the fruition of product development through to consumer purchase, (Perez-Sanchez, et al, 2003).

Since the majority of impacts of a products life cycle derive from the initial stages of NPD specification, a lack of responsible or consistent practice here presents far reaching environmental consequences (Wilson, 2010). To begin understanding where initial improvements can be made, it is worth placing into context the current definitions which are available to SMEs as potential guidelines for sustainable best practice for the reduction of environmental impacts.

Sustainability within the packaging sector is currently broken down into four main areas for potential implementation and improvement:

1. Optimization of resources through production (raw materials, recyclate, renewable's).
2. Maximizing system efficiencies, performance and fitness for purpose packaging design.
3. Minimization of production waste by design, (materials, systems or returned packaging).
4. Maximizing recovery of raw materials and energy (recycled and renewable materials), (Envirowise GG360, 2008)

According to Envirowise, these definitions can be generally grouped as Eco-Design best-practices and stem from the area of initial packaging specification. These definitions from Envirowise focus around tangible procedures for responsible packaging. Although contextual, this information does little to explain the reasons why these practices are important, how impact reduction is achieved, or the required steps to engage. Neither do these examples communicate the quantitative and econometric benefits needed for SMEs, to justify the engagement with new impact reductive practices.

As an addition to the steps laid out from Envirowise GG360, (2008), there may also be great potential in the way in which companies; educate themselves, work within their supply networks, set standards within industrial sectors or assign behaviors which seek to improve processes and impact reductive activities. If best-practices are only assigned within the areas of specification and materials, the opportunity to challenge the way in which organisations holistically engage with impact reductive activities and

their perceptions of it, is overlooked. Therefore, tackling perceptions around EIR benefits parallel to NPD specification, creates the opportunity to educate SME cultures towards improving NPD for long term sustainability.

Unfortunately, the diverse SME manufacturing sector faces a tough challenge in comprehending the vast range of environmental data required for process improvements. SMEs operate with a reduced capacity of staffing, while there is little to differentiate their workload from that of larger, more resource and knowledge rich organisations, (Wilson, Williams, Kemp, et-al,.2010). This makes additional tasks outside of those essential for day-to-day operation, a lesser priority. Due to this, a large percentage of SME businesses fall below the radar when it comes to being regulated for environmental compliance, additionally, if they turnover less than £2 million and 50 tonnes of packaging per annum, regulation procedures simply do not apply (Wilson, 2010).

This makes the need for EIR activities within this sector even more essential as SMEs which do not fall under any direct regulatory procedures or governance slip through loopholes in environmental best practice. With over 80'000 pages of European legislation for SME's to comply with, (Williamson *et al* 2006), understanding the relevance and importance of environmental regulation remains difficult for SMEs. According to (Wilson, 2010), SMEs thought that compliance was what the regulator identified on their behalf, rather than that included within legislation. Due to this lack of interaction between procedure and regulators, many SMEs believe that they are currently compliant and therefore not committing any offences, or, harming the environment.

According to Sme-nvironment (2003), who conducted a survey of SME firms, the smaller the business, the less free time and internal resources available to address

environmental issues. This means that many SME businesses are failing to take practical measures to reduce their impacts upon the environment, due to an inherently poor understanding of correct formal procedures.

In light of this, according to Sme-nvironment (2003), a large majority of these same firms welcomed information and advice on green issues to tackle the problem. This shows that accessibility and clarity of environmental data is also an important factor for change with SMEs, alongside providing structures which can align with differing SME operations. According to (Wilson, 2010), SME's may simply be unaware that their compliances and practices are lacking due to the inability to ask the right questions.

2.3.2 Small and Medium Enterprises and Environmental Impacts

SMEs are collectively known to be responsible for up to 80% of environmental impacts in relation to collective poor compliance, (European Commission, 2006; Wilson, 2010), with an increase of 10% accountable pollution since 1995, *(Petts, 2000; Hillary, 1995).* Not only are SME's believed to be collectively responsible for a significant proportion of all industrial pollution in the UK (ECOTEC, 1998), but they are also considered to contribute far more environmental damage, than larger manufacturing companies in general (Friedman et al, 2000).

Even though not stated by (Friedman et al, 2000), this larger contribution of environmental impact from the SME sector is most likely a result of the high percentage of SME firms being 99.7% of all UK businesses. Although, this clearly highlights the importance of making improvements within this sector due to the scalable potential.

SME's can come under considerable pressure to address the wide range of factors required of them when bringing their new products to market. Environmental issues in relation to responsible NPD practice are considered from a range of sources including: legislation requirements, supply chain operations, trade associations and customer expectations and their own strategic targets for sustainability, if any, (Friedman, et al, 2000). Because of this complexity and limited resources, it is less common for SME's to work actively with environmental issues as opposed to larger sized firms. SME's tend to adhere to basic compliance levels or below at best, rather than pushing for excellence even though there are apparent benefits for doing so, (Hallstedt & Ny, 2009). Larger companies by comparison may typically be more adept with a structure in place which supports activities such as: environmental management systems (EMS), life cycle analysis (LCA), competitor analysis, business plans and budget and customer review systems. Yet within these larger organisations there still lacks a consistent and formal procedure to identify sustainability challenges and inform these at a senior level (Hallstedt & Ny, 2009).

Product and environmental departments within larger companies still seem to have difficulty communicating EIR in a way which fits decision support tools that senior management often use. Therefore, this means that sustainability measurements must be broken down into concrete categories / attributes that can be understood, quantified and addressed to stand a chance of becoming company policy. In particular for SMEs such diversity is not covered by any systematic support, resulting in operations sitting mostly at, or below levels of rated compliance (Hallstedt & Ny, 2009).

These problems at a senior management level are thought to be a major barrier to implementing sustainability efforts, especially for SMEs. This indicates deficiencies in regarding the ability to understand, interpret and define sustainability, its business case and to communicate it between organisational levels. According to Friedman, et al,

(2000), environmental improvements aimed towards management structures cannot depend solely on emphasizing moral considerations to get SMEs to improve their internal practices.

> *"SMEs are still trying to understand what the environment is, let alone be thinking about sustainable development. Finance drives the amount of effort SMEs will put into an environmental programme, it's very easy to think that you'd like to be green and conscientious but realistically, financially it's just not viable to push entirely in that direction." Friedman, et al, (2000). p.335*

Michelsen (2009) and Singer (2009) also argue that companies see little attraction in investing time and resources into making regulation changes for the environment, if such changes generate additional costs; or where the return on such investments is too long term and large infrastructure investments are subsequently required. Unless obvious cost-benefits or other tangible incentives can be recognised, sustainability may seem fruitless without a convincing argument and recognised potential profit margins (Envirowise, GG360, 2008). Garrett, et al, (2009) believes that considering the wider system of how SMEs work within their supply chains can help to capitalise on new approaches to networking and entrepreneurship within NPD. Therefore understanding the external influences which place pressure on SMEs, may help to refine how EIR activities can fit into the complexity of current working practices.

Additionally, with the implementation of an improved NPD practice for SMEs being one concern, another might be how environmental obligations are managed in parallel. If standardised NPD is lacking within small firms, how can it be expected that they exuberate proficiency with EIR activities when they are already overburdened.

2.4 Implementing Environmental Impact Reduction (EIR)

The development of new products is a complex activity, not only because of the numerous NPD stages, but also because of the associated environmental impacts. At a strategic level there is a need to map, understand and plan against these. The conceptual design phase at the front end of NPD is thought to be ultimately responsible for initiating around 80% of environmental impacts of any product, during its full life cycle of usefulness, (Wilson, 2010). With this in mind, the choices and options for product and production type are crucial at this initial stage and must encompass wider ecological aspects if the environmental footprint from manufacture is to be reduced (Hallstedt & Ny, 2009). This can be difficult for some companies where the technical and legislative procedures require more competency than may be readily available. Decisions at the conceptual design stage have to encompass and reflect not only the company's strategic objectives and environmental concerns, but also bear in mind the interests of stakeholders, available resources and the practicality of changing existing production procedures. (Envirowise, GG360, 2008; Envirowise, GG980, 2008). Collectively, this makes EIR activity difficult to integrate where SME management is overburdened, meaning that potential compliances are overlooked.

It is worth considering the various levels of engagement towards compliance, which have been observed in various firms. Several case studies in pioneering companies have created the 5 stages of sustainability integration, Hallstedt & Ny, (2009) p.704:

1. *'Pre-Compliance:* Ignoring sustainability and opposing related regulations.

2. *Compliance:* Obeying laws and regulations on labor, environment, health and safety.

3. *Beyond Compliance:* Recognizing the opportunity to cut costs mainly through higher resource efficiencies and reduction of waste, leading to both financial

and ecological gains. Sustainability is still separated from core business development.

4. *Integrated Strategy:* Sustainability is integrated in the company's vision and informs key business strategies to be more successful than competitors through innovation, design and improved financial risk assessments.

5. *Purpose and Passion:* This is actually not a next stage of development for most companies but rather a special type of companies, being originally designed to 'help saving the world'.

In order for SME organisations to progress with integrating higher levels of sustainability, it is clear from Hallstedt & Ny, (2009) that the financial justification is of significant importance. In order for firms to move 'beyond compliances' they must comprehend exactly how proposed resource efficiencies will lead them to financial and ecological gains. With currently around 80'000 pages of European Legislation for SME's to comply with (Wilson, 2010), comprehension of procedures or benefits presents a daunting task when attempting to filter out individual requirement.

A point raised by Vickers, (2009) states that governments need to give companies space to breathe and think strategically when working with environmental obligations alongside internal practices. Although, having space to breathe and think strategically is not necessarily indicative of encouraging a pro-active approach to self education, which facilitates the reduction of environmental impacts through better practice. According to Wilson (2010), too little is currently being done to actively target non-compliance within SME organisations to enforce or communicate responsible practice.

The practical importance and benefit of sustainability is argued by Finkbeiner, et al, (2010) to require a more structured delivery. This view is also shared by Liu, (2009) and Vickers, et al, (2009), where they also propose that a stronger connection between

managerial and eco design practices are needed for firms to comprehend new measures. Additionally, (Liu, 2009) and (Vickers, et al, 2009) claim that an improvement between research, innovation communities and policy management are required, to inform a more pro-active approach towards sustainability all round.

This approach could be a desirable proposition when aligned with policy activities at a NPD level to inform criteria for improved sustainable product developments. But in terms of an effective approach for current SME management structures, changes first need to begin within organisations at a ground level. According to (Liu, 2009) and (Vickers, et al, 2009), addressing behaviour at a micro level then paves the way for the acceptance of wider systems of information and further impact reductive collaborations through more in depth understanding.

Rosen (2009) and Tovey, et al (2010) comment that those approaching sustainable issues by way of innovation generally require a more multidisciplinary approach. This is required in order to address the divergence of opinions, perspectives and insights for new processes and ways of working. (Curran, 2009) and (Kuhlman, 2010) propose that it is essential to discover an effective way of bringing differing disciplines and perspectives together with more co-operation. With this in mind, what is presented here is the need to utilise available intellectual resources efficiently to collaborate and build understanding towards environmental criteria.

2.5 Frameworks for Sustainability within New Product Development

As part of a broader strategy for SME companies to manage their environmental impacts, the European Union (EU) Commission in 1993 developed the environmental-management and audit schemes, better known as the EMAS regulation. EMAS is voluntary in nature and application is aimed to enable organisations to assess, manage

and continuously improve their environmental credentials. Through EMAS, these credentials can be reviewed and tracked regularly to provide a basis for managerial decision-making for performance improvements, (Hillary, 2004).

Compliance with EMAS is comprehensive and requires constant monitoring and evaluation of key resources such as emissions, wastes, water usage, energy usage, material usages and bio-diversity within the firm. This is so as to provide current benchmarks for evaluation, or accreditation. This comprehensive approach is inspired by, and based on the original UK Environmental Management System (EMS) standards; BS 7750, of which both have now been superseded by the current international EMS standard; ISO 14001. These voluntary regulations were designed to provide all businesses with the means to develop systematic approaches to environmental performance and complement normative regulation, while at the same time being relevant and applicable to small and medium sized firms, (Hillary, 2004).

According to (Goodchild, 1998), the disadvantages experienced by SMEs during EMS implementations revolve around the impact on resources of cost, time and skills required for effective practice. Components of the EMS have also failed to meet SME firm expectations, where additional tasks did not integrate smoothly into their current systems of operation (Hillary, 1997). Additionally, the cost of required consultation and the lack of quality advice as a result leading to misdirection, have only contributed to the development of bureaucratic and ineffective systems (Nalad, 1997; KPMG, 1997). As a consequence, SME firms have a dim impression of the inappropriate nature of formal EMSs' (Court, 1996), creating a significant barrier towards sustainable development for smaller sized companies.

(Netregs, 2009), more recently reflects these findings, where they report that;

> *"The majority of businesses considered an Environmental Management System to be of 'some use' or of 'little use' to their business and in particular, there was also a high proportion of businesses with 0-9 employees considering them to be of 'no use' whatsoever." Netregs, (2009), p.2*

It is becoming clear that a large majority of SMEs do not consider nor understand the benefits of a formalised approach towards environmental management systems. (Netregs, 2009), concludes that whilst this may be understandable for small family run businesses, it is more surprising that larger sized firms of the 50 to 250 employee size also struggle. In Hillary's (2004) work, she writes that SMEs are largely ill informed about EMSs', how they work and what apparent benefits might be derived from their implementation. As such; ISO 14001 and EMAS frameworks hold little interest and motivation for this sector, (Baylis, 1997; Charlesworth, 1998). Despite a concerted effort by policy makers to present the business case for sustainability, by portraying the measures as providing potential cost reductions, managers for SME firms still view environmental activity as expensive to undertake, resulting in resistance to voluntarily improving internal performances, (Hillary, 2000; Revell, 2007; Rutherfoord et al, 2000).

Adding to the negative perceptions of internal cost implications, Revell, (2007) points out that neither supply chain pressure nor consumer demand are sufficient drivers for environmental reform to any degree amongst SME firms. Results from 33 studies showed that the SME community experienced little pressure from customers and stakeholders to adopt new EMS systems, and even less collaboration on environmental management within the supply chain, (Wycherly, 1999). According to Revell, (2007), owner managers of SME firms need clear and accessible information and support

regarding potential environmental responsibilities. He believes that consultation and dialogue around environmental policies are crucially important to deliver this.

While it is important to recognise that the lack of discussion within supply chains can impact SME sustainable practices, many smaller businesses would actually like to improve their environmental performances, but simply don't know where to begin, (Netregs, 2009). When attempting to raise awareness of the potential business benefits associated with regulation and environmental practice, educating a suitable approach for SMEs is the single most critical factor.

Netregs who offer online advice are of the opinion that SME education methods need to reflect current industrial practices, to make information relevant to managers;

> *"Ultimately, environmental issues are unlikely to take precedence over day-to-day running of the business or winning orders, but if they can be addressed as an intrinsic part of these activities, then improvements can be made that have a positive effect on the bottom line." Sme-nvironment, (2003), p.3*

Communicating environmental practices in a way which managers can quantify and relate to is a challenge due to the varied and habitual nature of SMEs. To overcome these difficulties, various 'toolkits' have been created and offered to SME companies, which aim to assist with implementing steps toward impact reduction. One significant attempt to communicate bottom line benefits through new practice is the 'Better Business Pack' (BBP), which was developed with 170 SME organisations with the aim to improve performance and revenue without outside 'intervention' (Friedman et al, 2000). The BBP was developed as a self standing tool-kit and provided step-by-step guidance on four main environment-related issues: purchasing, supply chain practices, waste management's, transport and utilities.

Success of the tool, according to Friedman et al, (2000), mostly relied upon SME firms initially having the motivation internally to act in a more sustainable manner rather than responding to external pressures. But, even where motivation was initially present, the issue of effort and time required by SME's before returns were evident was a major barrier for uptake. Additionally, the format of delivery for the BBP was text heavy meaning significant time and dedication was required to navigate the 70 page long document. Where a company is pressed for time in a competitive market, it is a real challenge to get management to step outside of normal practices which could be seen as nothing more than a distraction;

> *"Closely related to motivation is the issue of the effort and time required by SMEs before returns are evident. It was argued by one intermediary that `SMEs are looking for a quick payback period' and that `a strong correlation' exists between the time and effort required, and the level of overall motivation." Friedman et al, (2000), p.333*

This reflects a major barrier for SMEs, if financial or environmental returns are not experienced within a short period of time, management can become de-motivated and fail to see a toolkit programme through to fruition. Vickers and Boyle (2009), conclude that too much emphasis currently exists on the creation of environmental tool-kits and little emphasis is sought on the methods of implementation and improvement of these current tools in practice.

2.5.1 Adaptive Frameworks

One solution might be a universal approach which works on an individual firm to firm basis, providing comprehension of EIR activities against available management resources. In relation to such an approach Manzini (2009) comments that transcending

core values into a format which functions for companies of varying size and capacity is desirable but also a major challenge. This is also supported by Michelsen (2009) and Martens and Moshin (2009), who proposed that more research needs to be done to guide the development of strategies and policies which can encourage engagement with sustainability, through new paradigms and methods of innovation.

Bridging the SME size gap when creating new systems is a difficult task as resource and experience will vary from company to company. A new approach will need to innovate in the way in which individual companies access information and perceive the relevance in practice. Smaller companies may need a step by step approach when self educating EIR activities, while having the flexibility to tradeoff between choices at an operational level. Ross (2010) supports the proposition that such an approach would work well as an initial procedural method for sustainable implementation, eventually evolving to become a central reference point for decision making once accepted into managerial practice.

With the steadily increasing number of regulatory procedures, a question is proposed of how a tool-kit system might be used in conjunction with managerial strategy when planning for sustainability and its various requirements, (Martens & Moshin, et al, 2009). One proposed method to bridge this gap is a 'Framework for Sustainable Development' (FFSD), (Gasparatos, 2009). An FFSD can be implemented for building a company specific definition of sustainability, based on internal strategic objectives of the firm. These strategic objectives would be applicable and specific to activities within the organisational sphere of influence on a company specific level, (Hallstedt & Ny, 2009). Building an FFSD enables the firm to decide where it feels sustainability is important and applicable within the organisation, developing their own criteria. According to (Gasparatos, 2009), creating company specific criteria allows for a more open-ended non-prescriptive co-creation towards sustainability.

According to Hallstedt and Ny, et-al. (2009), encouraging a pro-active engagement towards impact reductions presents a unique opportunity to avoid costs or fines; identify new market opportunities; and improve productivity and enhancement of company brand. The real challenge for the uptake of a new approach really hinges around the implementation (Mulvihill & Kramkowski, 2010; Finkbeiner et-al., 2010), of sustainability and its various activities, while catering for entrenched habits and behavior within company strategy (Singer, et-al., 2010). Once a system is created which engages SME organisations on a level which is comprehendible, the benefits towards impact reductive activities can be put forwards in a manner which is receptive and relevant.

2.6 Regulatory Procedures and Obligations for Product Packaging

According to Williamson (2006), it is a commonly held view that environmental regulation has a negative impact on business resource which can reduce the competitiveness of the firm. With smaller organisations this is particularly a problem, since the burden and complexity of regulatory compliance can bear more heavily on smaller firms as oppose to large, (Fletcher, 2001). A report submitted by the Small Business Service (SBS, 2004) also confirmed this in a statement which reads;

> *"Although government regulation has a vital role in ensuring that markets operate efficiently, excessive, unnecessary or poorly implemented regulation can reduce the efficiency with which markets can operate" SBS, (2004), p.6*

Williamson (2006) continues that regulation has become one of the main national issues of concern for UK businesses, and that firms are spending increasing amounts of time and money on addressing compliance procedures rather than creating wealth and capital. Slowdowns in the economy alongside time and resource pressures in small

businesses can also contribute to the low priority given to environmental matters (Sme-nvironment, 2003).

Revell (2007) comments that with smaller firms, perceptions of additional cost, weak enforcements from the regulator, coupled with a general lack of awareness within this sector has encouraged a state of 'vulnerable compliance' within UK SME firms. In a study by Petts et al. (1999), a survey with over 1000 SME's within England and Wales contributed to supporting this perspective and it was concluded that:

> *"While the majority of SMEs are not deliberately non-compliant they are vulnerable to this state, particularly where there is a lack of awareness of, and empathy with, regulation. Combined with the apparent failure to see the environment as a cost advantage, the capacity and feasibility to act in the majority of SMEs does not match the generally positive culture." (Petts et al., 1999, p. 28).*

This is despite a concerted attempt from UK policy makers who attempt to portray 'eco-efficiency' as a typically cost reducing activity (Revell, 2007). In a further compilation of research study by Hillary (2000), she too placed the SME community at a distinct disadvantage in managing their environmental impacts, concluding that the SME community is;

> *"Largely ignorant of its environmental impacts and the legislation that governs it; oblivious of the importance of sustainability; cynical of the benefits of self-regulation and the management tools that could assist it in tackling its environmental performance; difficult to reach, mobilise or engage in any improvements to do with the environment." (Hillary, 2000, p. 18).*

Based on this perspective, SMEs have very little incentive to self-regulate given that the apparent lack of proficiency and understanding leaves many unconvinced of the

real business case for sustainability. Attempts to encourage SMEs to create voluntary environmental programs are usually focused around the apparent and potential financial gains to be made from making improvements (Revell, 2007), and placing a great deal of 'faith' in sustainability without much indicative proof.

The existence of self regulation frameworks through internal systems such as EMSs', according to Petts (2000), only really highlights the perceived weakness of external regulatory procedures and is compatible with the view that regulatory compliance alone will not bring about the change required for sustainable development, (de Bruijn and Tukker, 2000). According to Petts (2000), a positive shift in business attitudes towards the environment will most likely be dependent upon the embedding of environmental values at all levels of business. Therefore there is a pressing need to better understand the cultures of individual organisations and how they choose to work within this context.

A study by Netregs, (Sme-nvironment, 2003) also supported this view, that the lack of action towards regulations was largely a result of low environmental awareness from smaller firms. Petts (2000) supports these findings in saying that it is ultimately difficult for SMEs to manage their environmental impacts, as exactly what and how this should be done may typically be unclear to them. This situation may be resolvable if certain elements of regulation can be made more 'certain' to those with less knowledge. For example: if regulation is stable, predictable, time efficient, and supported by technically strong regulators who can work alongside SMEs, engagements may not necessarily stifle innovation and competitiveness, (Porter and van der Linde, 1995). Companies need the opportunity to digest and integrate regulation procedures, while environmental initiatives should be as short as possible and represent real value for money, (Friedman et al, 2000).

2.6.1 Packaging Specifications

For every product placed on the market the product packaging is deemed an essential element, although considering the volumes of product packaging manufactured per annum versus the potential life span, the current system appears far from resource efficient. Packaging essentially serves to protect the product during transit; enable presentation to the consumer; compete for shelf presence with competitors; and communicate through visual language, the transcending brand quality to encourage purchase (Envirowise GG360, 2008). Packaging design for SMEs can be an unattended task with low priority, (Wilson, 2010) due to more pressing issues within company strategy. In contrast to SME perceptions, improving packaging specifications can ultimately provide significantly improved resource efficiencies; streamlined costs; improved brand image; as well as being more ecologically sustainable, (Envirowise, GG360, 2008), (Envirowise, GG980, 2008).

Given the benefits, regulatory procedures at an SME level of understanding tend to be overly intricate, widely misunderstood, poorly implemented and poorly policed from the side of the regulator, (Wilson, 2010). According to Wilson, (2010), regulations are generally monitored externally with an infrequent at best policing system resulting in the role of regulation failing to become promoted with SME manufacturers. Those who are unaware or misinformed of the true technical, legislative or opportunistic areas which sustainable practice can provide, will essentially contribute to non-optimum product specifications placed within UK supply chains, (Envirowise, GG360, 2008).

In addition to SMEs being sceptical towards regulation, a low awareness and lack of pressure from customers (the most important driver for environmental improvements and EMS adoption) means that few efforts are made to engage, (Hillary, 2000). It was found by Abrams, (1998); Court, (1996), that a lack of regulatory integration within

SMEs was partly down to the problem of locating, and or, having time to locate a consistent resource of quality information. Comparatively, the Department of Trade and Industry (DTI) state that the regulations and their application within industry tend to be generally self policing where larger companies are concerned (Wilson, 2010).

Being a larger organisation goes hand in hand with providing leverage within supply chains due to the larger order numbers placed and an expected awareness of environmental responsibility. This then puts greater pressure upon packaging suppliers to ensure that packaging specified is of a higher standard for compliance, especially where more exposure is concerned through branded companies. Supply chains which get left outside of this loop of compliance, more often than not tend to be where no big company is involved such as SMEs (Wilson, Williams, Kemp, et al., 2010) due to their reduced size, lack of influence, knowledge and minimal order volumes.

2.6.2 Producer Responsibility Obligations and Regulations (PROR)

Governmental regulatory procedures for the monitoring of product packaging design, and product packaging wastes, are generally separated into two main subject areas;

- Producer Responsibility Obligations Regulations 1997, (PROR), dealing with increasing percentages of packaging wastes contributed by 'producers and importers' of packaging throughout the supply chain,

- Packaging Essential Requirements 1998, (PER), dealing with the design and integrity of product packaging, placed upon the market by the product producers / manufacturers.

Although technically separate in operation, both regulations aim to work in tandem to jointly regulate all general packaging practices, from responsible design and

specification of correct and appropriate material choices, to the eventual disposal of resulting waste product. In relation to how the supply and development of packaging takes place within the supply chain, it is worth considering the contexts of which they apply and to whom and what this means for SMEs.

There are two types of regulatory classification assigned to those responsible for packaging within the supply chain, these being: the producers of packaging, and the importers of packaging. ‘Producers’ are those which manufacture packaging materials and turn these materials into the packaging product, producers are therefore also known as ‘suppliers’. ‘Importers’ are those who purchase the manufactured packaging from the producers / suppliers, and place their product inside ready for market entry. 'Customers' would then be defined as retail outlets, which pass the product on to the consumer, (Envirowise, GG360, 2008).

Producer Responsibility Obligations Regulations (PROR), are designed to place a considerable amount of responsibility upon the producers ‘and’ importers of packaging to encourage them to deal with a proportionate percentage of packaging waste being passed down the packaging supply chain. This percentage of packaging waste has to be dealt with in a responsible manner and directed either for the purposes of packaging-recycling or energy-recovery, (Envirowise, GG360, 2008). The obligatory percentage is dependent upon the position within the supply chain under question and also if the packaging has been imported from outside UK boarders.

Percentage obligations from outside the UK are automatically additional responsibilities of the UK importer, when dealing with packaging waste for PROR. For example:

Manufacturer;	6%	(plus 6% if imported from Manufacturer outside of UK)
Packaging Producer;	9%	(plus 6% if material imported from outside of UK)
Pack-filler;	37%	(plus 9% and 6% if imported from outside of the UK)
Retailer;	48%	(plus 37%, 9%, 6% if imported from outside of the UK)

(Wilson, 2010)

Apart from being obliged to dispose of own product waste, manufacturing firms are also obligated to deal with 100% of any product waste which is imported, but becomes waste on their premises. The monitoring of these compliances for correct waste disposals falls under the wing of the Environment Agency (EA), or independent compliance schemes which can manage waste disposals on the behalf of the firm for a charge. Registration is required in either case to provide evidence for the regulator that tonnages of packaging waste have been disposed of responsibly in relation to the firm's individual obligations. Evidence of managed wastes are collected in the manner of Packaging Recovery Notes (PRNs), which are supplied by the re-processor who deals with submitted packaging waste at an individual cost upon submission. These PRNs are then subsequently submitted to the regulating bodies who register the PRNs as proof of responsible practice, (Envirowise, GG360, 2008).

The compliance of SME's with regard PROR practices tends to be poor due to the complexity of working out individual obligations. Additionally there is also failure with SMEs to register with the EA and the various compliance schemes with which the EA places a considerable faith, (Bland et al., 2004; Fairman and Yapp, 2005;

Wilson et al., 2007; Atkins, 2007; Wilson and Williams, 2008). The EA acknowledge that the biggest problem for SME organisations when dealing with regulation, is working out their own obligations (Wilson, 2010). Lack of SME understanding backed up with poor enforcement through sporadic compliance visits from the EA, means a large majority of SMEs go unregulated and poorly policed, (Gunningham, 2002).

EA risk assessments are used in order to quantify and justify, rather than inform the level of inspection required for monitoring a firm's compliance. While this may allow for some prioritisation as to which firms require the most attention, this is essentially performed at the detriment of ensuring actual relative compliance on an individual firm by firm basis (Wilson, 2010). Additionally, companies which turnover less than 2 million sterling per annum and handle less than 50 tonnes of packaging waste per annum are also not included under any direct regulatory regimes, (European Commission, 2006; Wilson, 2010). As a result there is currently less opportunity to identify individual non-compliances and promote the regulators role within industry within firms which are deemed a 'low priority' (Bell and McGillivray, 2006; Ends, 2003), or skim below the 'requirements'.

Lack of contact with the regulator due to the low frequency of inspections creates a situation where businesses refrain in coming forwards voluntarily with potential compliance failures. Therefore it is less likely that SME companies become subject to formalised compliance audits due to the nature of sporadic inspection and enforcement regimes in practice, or see the value in such.

2.6.3 Packaging Essential Requirements (PER)

Small businesses account for 99.7% of the UK economy at a total of 4.7 million businesses nationwide. Only 5500 of these are currently obligated under the PROR regulations due to turnover and tonnage restrictions imposed by the regulator, (Wilson, 2010).

Companies which are obliged to comply with the Packaging Essential Requirements regulations, (PER), are typically greater in number due to the PER being based around packaging 'design', regardless of company size. Trading standards whose position is to monitor and regulate the PER, admit that too many loopholes make it difficult to police the system and require tougher laws and higher fines (Wilson, 2010; Gunningham, 2002).

The PER Regulations are technically the UK's first Eco-Design practices within the area of packaging design. The overriding purpose of the PER regulations is to place considerable responsibility on the person that places packaging onto the market, to ensure that the design of the packaging is to a level which is fit-for-purpose for the contents of which it is to carry (Envirowise GG360, 2008).

Packaging must also be designed, produced and commercialised to permit the re-use or recovery of materials used, including recycling processes in order to minimise packaging impact through disposal. The PER regulations unlike the PROR regulations, do not have a threshold to which certain companies are or are not obligated, instead the obligation simply applies to the company that places the packaging onto the marketplace. This is usually the end retailer but also applies to the packers and fillers of the imported packaging, i.e. product manufacturing SME companies.

Packaging designs which comply with PER regulations must meet strict criteria in terms of being deemed fit-for purpose by the regulating local Trading Standards. Fit

for purpose criteria states that packaging must be optimised to protect its contents, while at the same time using the minimum amount of material necessary. This presents a grey area in defining 'optimum', and presenting a case for and against where presentation packaging is concerned. Evidence of compliance is requested in the form of tests and performance criteria from the producer of the packaging to verify that the standards are met and compliant. Those with little expertise in this area must then rely heavily upon their suppliers when seeking specifications to meet their individual obligations. Although, it is thought that the majority of SMEs have never heard of the PER regulations, let alone implement them (Wilson, 2010, Gunningham, 2002, Envirowise GG360, 2008).

The lack of competence in terms of PER specification is significant within the SME sector, where common non-compliances tend to relate to a failure to reduce packaging to its minimal amounts. According to Wilson (2010), compliance criteria for PER regulations from Trading Standards, lacks clarity as to where and how firms should compile technical information. The lack of enforcement activity is also a major flaw with relatively minor pro-active enforcement and only 6 prosecutions for PER regulations since 1998, (Bland et al., 2004; Fairman and Yapp, 2005; OECD (2004); Wilson and Williams, 2008; Wilson et al., 2007).

This highlights the importance of education for SME companies around environmental impact reduction, and demonstrating the various rewards which stem from it.

2.7 The Gap in Practice for Small and Medium Enterprises

A problematic scenario has been presented within the large UK SME sector in that SMEs are currently ill advised of correct regulatory procedures; unregulated nor inspected; and, contribute considerable environmental impacts due to a present lack of awareness, responsibility and knowledge.

Finding a method which can disseminate appropriate advice throughout the SME community is a challenge. This is not just because SME firms differ in size and experience, but also because the general culture for environmental improvement is not particularly embedded within SME management structures. This is not to say that environmental practices are of little use to SMEs, as improvements can provide efficiencies in resource usage and overall cost reductions when integrated as part of company policy.

Current failures to see the importance of environmental improvements can be associated with a lack of communication with both the regulators and supply chain partners, leaving SMEs isolated. With SMEs working independently with little guideline to best practice or incentive to change, typical NPD frameworks will vary from firm to firm without a common structure. This makes additional EIR activity a challenge where SME organisational structures are unaccommodating to new ways of working, or simply don't support change.

Toolkits and frameworks which aim to assist SME organisations have proved to be off-putting for small firms, due to the laborious nature of text heavy content, perceived investment of time and staff resources required for implementation, and lack of perceived benefit. Not only do SMEs fail to have the time to engage with official documentation, but the capacity to absorb and respond to the content may also be limited due to cognitive overload where text heavy documentation is presented. Where

information is over complex, the less likely the readership is to read the guidance properly. Simplifying current guidance would require massive investment in time from the authorship of the documentation to produce specific guidance for specific circumstances of SMEs.

This has paved the way for providing a format which prompts the SME to self assess their current practices, while identifying potential factors for improvement in a way which is comprehendible and educational. Methods which consider the capability of the SME and balance this against EIR activity hold potential to foster new policies for strategy and growth. Where external authoritative measures have previously failed, it would be worth reversing the problem to encourage SMEs to identify and address their own EIR requirements from the inside-out; making use of the industrial timeline to interweave EIR practices within stage and gate NPD.

Targeting improvements at the initial stages of NPD brings potential improvements to the forefront of company strategy, enabling key sustainability criteria to be considered within initial development phases. Even where competency is low, working in unison with EIR at the start of the industrial timeline could essentially reduce environmental impact as part of project success criteria, rather than treating impact reduction as a separate activity.

The complexity of practices which are required of SMEs when integrating impact reductive activity into NPD presents a varied and non-uniform range of possible scenarios to encompass. Therefore, this research aims to work towards a simple but uniform method which bridges the differences in SME company scale and resource capacity. This method aims to encourage responsible practice for SMEs, who are situated between their packaging suppliers and retail customers. This method aims to guide SMEs by developing their own criteria in relevance to their capacity for change,

which will subsequently indicate potential alternatives to reduce environmental impact. To move away from the text heavy documentation, this method seeks to use visual language as a guidance to navigate EIR activities as an alternative to bullet point text format. Using a visual language such as process mapping techniques can facilitate the 'story' of EIR as a journey for the user, which guides and prompts use.

Providing the SME with a capacity to ask more informed questions with a premise to making small but beneficial improvements could place pressure on suppliers to improving the overall quality of services rendered. This may additionally improve the professional status of SME firms, in regards to that of larger more influential companies. Because of the ad-hoc culture of NPD within the SME sector, improvements within decision-making structures must have clarity and provide relevance to firm specific strategy.

Informed choices originating within the early stages of SME NPD may then begin to reduce the long-term environmental implications on a broader scale where external regulatory control has failed to create significant impact. There is therefore a need to build a framework which can impart wisdom in regards to environmental impact reductions. This would need to work on a level which provides steps to implementation and demonstrates gain. Such a framework would initially act as an indicator towards EIR improvements, but as awareness and acceptance grows would become a central reference point for decision making. Therefore, a cultural shift must happen which educates why sustainable factors are relevant to the organisation through a process of engagement and realisation.

To inform this framework, data will be required as to where the most common EIR challenges are currently presented within the SME sector, in order to define key criteria for effective implementation of the proposed framework.

The next chapter will address the method which has been chosen to collect the broad set of SME industrial data. This broad set of SME data will be used to define the key factors which are most relevant to implementing a new system framework for SME EIR activities. Key points which have been addressed during the literature review will provide considerations as to which method is most appropriate gaining industrial data from product producing SMEs.

3: METHODOLOGY

3.1 Introduction

This chapter will focus on the consideration of research methods to determine which will be the most appropriate for gathering data about NPD and EIR from within the SME manufacturing sector. This will be for the purposes of constructing an EIR framework, which will use visual language techniques to communicate the complexity of environmental data. As discussed within the literature review, a current need exists to enable SME organisations to self manage their environmental impacts through their decision-making criteria in NPD. Even though SMEs are small, the collective of these organisations creates overwhelming environmental impact, therefore small changes within each of these organisations, can manifest overall significant environmental improvements.

To understand the choices for the selection of appropriate methods, this chapter will begin by setting out the data requirements needed, to bring value to the research questions raised in the previous chapter. Methods will be discussed in relation to their effectiveness in gathering the required data within the SME sector to enable effective analysis, and any potential difficulties which may be encountered from working within this field.

In order to test the hypothesis that using a visual language will assist SMEs when interacting with the complexities of sustainability and its associated documentation, appropriate methods for obtaining data within this sector, must therefore be able to:

1. Show SME levels of current engagement towards sustainable practices within NPD. This will need to reflect regulation procedures, working with others within the immediate supply chains, and any potential best practices currently used within NPD.

2. Accommodate the differences between organisational sizes. This will need to reflect the size variances highlighted within the literature review between SMEs ranging from 10 to 50 employees, up to 250 employees.

3. Be able to capture the current procedures and practices within the existing supply chains with which NPD is carried out. This will need to clarify how SME organisations carry out their NPD processes, and the variance with which this happens between organisations.

4. Identify organisational behaviour characteristics of SMEs. This will need to demonstrate current attitudes of SMEs towards sustainability, and the relevance of sustainability to the organisation.

5. Gather the elements required which can inform a visual framework to assist SMEs with day-to-day understanding of complex environmental data. This will need to cover the broad range of relevant information identified throughout the course of the research.

3.2 The Overall Aims for a Process Mapping Solution and Concerns for Data Collection

This research aims to create a visual framework for SME organisations to support engagement with sustainability practices and regulation procedures by way of process mapping. In order for a visual framework to be effective within the SME community, value from the collected data must contribute to building a framework which aims to:

1. Be comprehendible to SME organisations regardless of their size and experience, for a universal implementation of a proposed framework within the SME sector.

2. Be succinct in relation to internal NPD procedures and relative stages of product development, so that interaction with the framework can be integrated easily within current working practices.

3. Be succinct in relation to external NPD procedures and relative stages, so that the consequences of decisions made can be implemented throughout supply chains with any associated partners.

4. Cater for the placing of the SME organisation within the wider operational system of supply and demand networks, to improve any channels of communication with external organisations.

5. Contain all relevant data highlighted from the research which will address the following;
    a. Current gaps within SME knowledge of better environmental practices and regulatory procedures, which are currently overlooked.
    b. Demonstrates clear instruction for the effective implementation of areas which are currently overlooked, in line with existing SME NPD activities.
    c. Demonstrates benefit and reward which can justify any engagements of time and resource in the process mapping procedure.

When considering the above aims it is clear there are a number of essential areas which will need to be individually addressed, to provide a framework which is comprehensive and applicable within SME organisational management structures.

Therefore appropriate methodology must be chosen which strikes a balance between both the levels of detail required from the data to inform effective mapping and the accessibility of the research subject to achieve the above aims.

Certain industrial concerns will subsequently need to be taken into account, when proposing the effectiveness of research methods within the SME sector. These concerns are:

1. A difficulty is presented in getting close to the SME sector for data collection and observation. The current nature of SMEs in literature states that SME's are typically short of time and resource to engage with additional activity, outside of that which is deemed essentially important for the daily running of the business.

2. SME organisations are typically over researched and over contacted due to the potential nature of improvement within the sector. This currently makes consistent access to professional SME organisations problematic, on a regular basis for those who wish to study their practices.

3. Due to the complexity of information which needs to be obtained and manifested into a new delivery system, iterations of refinement and confirmation will be required to systematically improve process mapping design by stages of investigation and subsequent justification.

4. Working specifically with a small sample size of SME organisations may restrict the overall flexibility of the intended generic approach for visually mapping complex data, due to the invariable knowledge contributed from

SME's in general. Therefore working broadly will allow for the wider consideration of where common issues can be addressed.

5. The research will initially need to focus out broadly to discover and confirm key themes and subject areas to be included within the data map, and then focus in without subjectivity. This will be to present the required generic solutions, which are broadly essential to the wider SME community.

With EIR being complex in nature and SME varied approaches to NPD, it is essential that the research design allows for a succession of broad investigatory stages followed directly by refinement on emergent key themes. The practice of exploring as an iterative process works well where little is known about the subject area and many variables may be present, as each stage of discovery can be assessed and priorities can be set for the next phase of investigation. As the breadth and depth of knowledge continuously grows through project development, the focus on important key themes and areas for improvement will become more apparent.

3.3 Quantitative and Qualitative Data Collection

The approach to qualitative research allows the design and structure of data collection to be emergent in situations where a detailed understanding of the research area is not present at initiation. Therefore, the research must be played by ear and unfold as key themes begin to emerge, (Lincoln and Guba, 1985). This emergent approach (Lincoln and Guba, 1985) is typically structured where analysis of data is used to subsequently inform the identification of new concepts and ideas, which require deeper investigation. For example, this approach allows for individual studies which have been collected, to then be reported back toward the selected research participants for

further and deeper discussion on the emergent topics. This then enables cross referencing of points of view between participants, discussion and confirmation on emergent key themes as a collective and integral part of the emergent approach to qualitative research. From the study of the emergent themes, criteria can then be developed which provides a grounded theory that can be transferred from the local to the global level (Deem, 1998).

The essential components within a qualitative study will include literature review, theoretical framework, fieldwork, purposive sampling, appropriate data collection techniques, emergent design and iteration, and grounded theory forming a tentative working hypothesis which leads to the transference of findings based on contextual applicability (Pickard, 2007). Qualitative research generally contains an integral amount of the emergent design, which is based on the belief that the researcher does not know what he or she does not know, at the beginning of the study (Lincoln and Guba, 1985). Qualitative research then allows the key themes to emerge as the study progresses.

In comparison, quantitative research is far more linear than that of qualitative research, as quantitative research essentially begins with a theoretical framework and subsequently a hypothesis, (Pickard, 2007) at the start of the research activity. This implies that elements of the research area are initially well defined at the start of the research activity and that key themes are already known to inform questioning on given topics. Quantitative research provides a more bounded approach from the offset, with the research variables defined early on in the process rather than emergently. This in essence is a more linear process than that of qualitative and provides less flexibility in approach due to the already defined boundaries of the research activity.

3.3.1 Mixed Methods Approach

Using a mix method approach to research can take advantage of the enquiry, experimentation and survey methods (resulting in numeric data collection), of which quantitative research provides while additionally using the contextual data provided through relevant case study which the qualitative approach contributes, (Armitage, 2007). Johnson and Onwuegbuzi (2004), discuss that the true goal of the mixed methods approach to research is not to replace a qualitative or quantitative approach, but moreover to draw from the strengths and then minimise the weaknesses of both single applications. This means that the mixed method combination of qualitative and quantitative research can effectively be used in combination as a third approach to the research investigation, (Tashakkori and Teddlie, 1998) where the subject matter may benefit from both methodology of enquiry.

It is discussed by Libarkin and Kurdziel (2002) that these combinations of approaches are beneficial, where qualitative analysis can provide the context in which is lacking from a purely quantitative research study; and quantitative analysis can equally widen the implications of a purely qualitative analysis. This means that an approach of this nature will effectively merge, integrate and connect both quantitative and qualitative results to allow for a more overall holistic understanding of the target research area, (Cresswell and Garett, 2008). It is explained by Tunnicliffe and Moussouri (2003), that not all aspects of the research problem can effectively be identified by any singular method. For this reason researchers need to be specific with exactly that which they wish to assess, in order to design an approach which can use the strengths of both mixed methods to inform their investigation at a deeper level.

As previously mentioned, the SME manufacturing sector typically demonstrates complexity in operations which must be addressed within the data collection to build a comprehensive visual mapping process for sustainability. This can effectively be

encompassed through using a mixed methods approach of broader data collection and analysis that combines the strengths of both approaches. Cresswell (2003), supports this by saying that the bringing together of both qualitative and quantitative methods will lead to more improved understanding of the overall research problem than either approach used solely on its own.

Progression of the research study in light of previous considerations mentioned in section 3.2 can make use of a mixed methods approach to investigate the complexity of SME sector in the following manner:

- *Qualitative,* in building a foundational system framework and gathering semi-structured responses in relation to key areas of issue for SME manufacturing organisations.

- Quantitative, in calculating data responses and common areas for improvement, for the proposal of further qualitative questioning.

- *Qualitative,* in structuring semi-structured questions to the SME manufacturing sector, allowing for experiences to be shared on an individual basis.
- Quantitative, in gathering this broad range of data and calculating key themes for improvement within the manufacturing sector, which are then to be placed within the proposed visual framework.

- *Qualitative,* in structuring improved visual frameworks based on research data and key themes for improvement which address these issues, and returning them for industrial review.

- *Qualitative,* in receiving improvements and recommendations for the refinement of the proposed visual framework.

Bergman (2008) refers to two separate research designs which aim to employ a mixed methods research approach to data collection and analysis, these two approaches to the research design are seen as: 'concurrent' and 'sequential'.

The concurrent approach aims to bring together both quantitative and qualitative data in parallel, with both forms of data being collected within the same time frame and then integrated in unison for analysis. The sequential approach uses one form of data to then extend and build upon the other iteratively, timing the implementation of research methods into distinct phases using one type of data before the other, when collecting and analysing.

Sequential approach is typically used when the researcher has one form of dataset initially, which is implemented in the development and activity of the following research phase, (Creswell 2007). The development of various visual frameworks throughout the research activity will be essential for gathering and synthesising collected data from the quantitative studies at each phase of investigation. This will allow for the consideration of where further research activity needs focus on the key areas of which SME's need to address. A sequential approach to the mixed methods research design is most suitable for both informing of the mapping process, to then subsequently represent the qualitative data.

This procedure is also reflected by Hanson et al. (2005), where a sequential mixed methods investigation can identify variables and constructs which can then be subsequently measured through the use of existing instruments, or in the context of

this research design; the development of new ones such as visual process mapping. According to Creswell et al. (2003), consideration will need to be placed in relation to the priority and integration of the data collected during a mixed method approach. Priority is used in relation to which method in the quantitative or qualitative approach holds a greater influence over the research study, and which method is more supporting in nature. According to Tashakkori and Teddlie (1998), the data analysis and integration of data between quantitative and qualitative research, may occur through analysis and separation by transforming the data, or by connecting the data analysis in some new way.

The connectivity in data analysis between mixed methods will be most suited to the construction of a visual mapping process as both quantitative and qualitative data is collected. This is also the most appropriate research approach as the visual mapping process will need to manage complex data, including NPD processes and frequencies of SME usage, where the variables are unknown and there is currently no guiding framework or theory. Therefore essentially, an exploratory and sequential mix method research approach will be needed.

3.3.2 Case Study Method

Due to the amount of knowledge to be gained within an area which needs much definition to develop theory, case study can be used to understand the relative process involved at a micro level. Case study approach can work well when the boundaries between the phenomenon and the context are not clearly evident. Yin (2002), comments that this can be the case when multiple sources of evidence are required as a combination of both fieldwork and the report of that fieldwork. The case study can therefore be both the process engaged in to investigate a phenomenon, and the report

of that fieldwork, (Pickard, 2007). Case study approaches are designed to study the particular within context and have specific purpose in use, and typically require direct access to the research participants in order to observe and document the activities being performed. This is reflected by Stake, (2003) p.203, who quotes that:

> *"Qualitative case study is characterised by researchers spending extended time, on-site, personally in contact with activities and operations of the case, reflecting, and revising meanings of what is going on."*

While this would be preferable in building a framework for a visual mapping process, the current SME manufacturing sector are typically difficult to initiate and sustain contact with. This being the case, maintained contact and close case study approach would not be practical to achieve within the timeframe of this research programme. Additionally this research aims to achieve a more general approach for the wider SME community. For this reason, the consideration towards working with a small group of industrial professionals who are committed throughout the research programme will provide greater consistency and feedback throughout, in comparison to attempting to maintain sustained SME contact.

3.3.3 Action Research and Grounded Theory Methods

Action research holds great value when investigating organisational functions (Bailey et al., 2004), and the workforce within it, with a view to improving service provisions through reflective practice, structure, and dissemination of the experiences gathered to the wider community. Action research would require direct involvement with the SME's throughout the research activity and being able to cycle the research activity within the situation of close contact to show proof of changes being made within the organisation. For the same reasons as described for case study, the application of

action research would not be suitable given the conditions of working within the SME sector, and the unpredictable nature of maintaining regular data sampling.

> *"Action research encourages practitioners to acquire the habit of research in the workplace and provide them with an approach that teaches them to critically evaluate their practice. Action research differs from other research approaches in that it assumes a tight coupling with research and action. Action research depends upon the collaborative problem-solving relationship of the researcher and the client with the aim of both parties solving a problem and generating new knowledge." Rowley, (2004), p.212.*

The approach between research and action is reflected in the overall practice of grounded theory. Grounded theory is the inaction of simultaneous data collection and analysis, (Charmaz, 2006), and therefore can be applied in ethnographic studies, case studies and the former mentioned action research. Grounded theory is more in relation to how data is collected and analysed than the entire research design itself. This is mostly applicable where the research questions are unknown and the entirety of the research subject area must be studied in order to gain insight. Therefore grounded theory is seen as a process of mixed method analysis and not the research method in its own right, but as a general method of comparative analysis, Glaser, (1978) p.116.

Although grounded theory would in effect prove beneficial to study the overall practices of SME manufacturing companies, this practice would not effectively inform the criteria for building visual process maps for informing sustainability, where a more specific focus is required and the gap in knowledge is currently defined.

3.3.4 Delphi Method

The overall research methodology as discussed will be a mixed method of quantitative and qualitative data analysis in sequential approach. Due to the difficulties in working closely with a large number of SME companies on a consistent basis, it is therefore practical to find a group of industrial professionals who can offer a wide range of experience and knowledge on an iterative basis.

The purpose of the Delphi study is to obtain the most reliable consensus of opinion from a group of experts, by commencing a series of questionnaires which are interspersed with controlled opinionated feedback, (Dalky and Helmer, 1963).

> *"The informed expert, with his resources of background knowledge and his cultivated sense of relevance and bearing of the generalities in particular cases, is best able to carry out the application of the quasi-laws necessary for reasoned prediction in his field. For the expert has at his ready disposal a large store of (mostly articulated) background knowledge and refined sensitivity to its relevance, through the intuitive application of which is often able to produce trustworthy personal probabilities regarding hypotheses in his area of expertness", Helmer and Rescher (1959), p. 31.*

Therefore, the validity of information when acknowledged by a number of legitimate assessors, provides a clear advantage to those possessing those shared attributes in finding consensus on a given topic, (Landry, 1983). Therefore, the Delphi study provides an aggregation of wider opinions to extract underlying topics within a formalised manner. In regards to sustainable supply chain management, research within this field has mainly been dominated by either case study or survey-based research approaches. Few attempts have essentially been made to take a broader approach to the overarching issues within its area , (Seuring, 2008), whereas the

Delphi method or better known as the 'expert survey' can provide a differing and effective approach. The Delphi method provides a way for structuring a good communication process to enable the group of individuals, as a whole, to deal with a complex problem. Standardised surveys by nature, imply that the data can be collected only once, whereas with the Delphi method, feedback is cross compared and re-presented to the panel for further iterations of improvement and refinement in gaining an overall consensus. According to Pickard, (2007), the key to conducting a good Delphi study lays in good planning structure, and is most likely take the following steps:

1. Decide on the general aims of the study and decide on the problem statement. Turn this into specific aims organised into a set of sequential tasks and issues to be resolved.

2. Review all relevant literature documentation and begin to discuss development of ideas with key informants or experts.

3. Identify the expert panel that will be able to inform discussions around the issues at the heart of the research investigation. It is better to have a small panel of consistent members rather than a larger panel, and subsequently struggle to gain feedback.

4. Design appropriate questionnaires outlining the key themes of the research orientated towards that which you need to know. Delphi studies always use questionnaires and are the only acceptable form of data collection within traditional Delphi method.

5. Create pilot cases of future questionnaires and propose these to panel members for a verified justification of direction and accuracy of information.

6. Release the questionnaire with intended target market, or expert panel including a number of open ended questions to encourage detail and descriptive narrative.

7. Process the returned information and return this to the expert panel for review and comment on the findings of Delphi study. This allows for further critique in focus towards refining the key themes of information from the research. Present the opportunity for panel members to make additional statements and comments.

8. Repeat this process as necessary until consensus is reached that the information obtained is consistent. Processing will be ongoing as data is processed between each round, it is usual for Delphi study to include anywhere between 3 to 7 rounds of refinement processes, the goal of each round to focusing with more detail.

SMEs will mostly play their part when working directly through the questionnaires, but only once the groundwork has been done in gathering a broad range of testable data to put back to the SME community. This will be to ensure that the visual framework is more open-ended and generic, rather than specific to a minority of SME's.

The overriding objective of using a Delphi study is to make the most of expert experience where it is available; it is therefore counter-productive to invite anybody onto the panel who is not directly relevant to obtaining information of that which is needed to complete the research objectives. Quality and not quantity is of most importance. It may not always be achievable to obtain consensus between all panel members, but the orientation of this method is concerned with the sharing of views

and giving the research the opportunity to reconsider these views, based on the opposing arguments and perspective, (Pickard, 2007).

The SME manufacturing industry is heterogeneous in nature where organisations are found to differ greatly in size and capacity, resource, experience and knowledge, communication and incentive. Being able to compare and contrast viewpoints from those directly related to this industry in a way which is also open ended and heterogeneous, will allow for solutions which are more widely generic, rather than subjective to the minority.

The Delphi method according to Pickard, (2007) offers a great deal in terms of exploring and developing practical issues within a wide variety of contexts. Delphi method by nature is a highly structured process but this does not mean that restriction applies to the formal structure; as well justified modifications can result in deeper and richer insights. Interspersed between the various stages of panel involvement, system maps will be created alongside questionnaires, to visually construct a framework for the resulting data. Both of these will be evaluated by the panel sequentially. One of the major concerns for the Delphi method will be the level of consistent commitment from the expert panel and sample size required during the SME questionnaire phase. Both of these issues will be discussed later in the thesis.

3.3.5 Concept Mapping, Process Mapping and Affinity Diagrams

Key themes from the literature review must be structured to ensure the right questions are being asked of the expert panel. Pickard, (2002) discusses that one way to approach this is to draw a concept map. A concept map enables the researcher to identify various touch points within the literature and emerging data and begin to link these together in a visual manner. Pickard, (2002) continues to comment that seeing a

picture of emergent key themes prevents an information overload when dealing with complex data information in the form of concept maps.

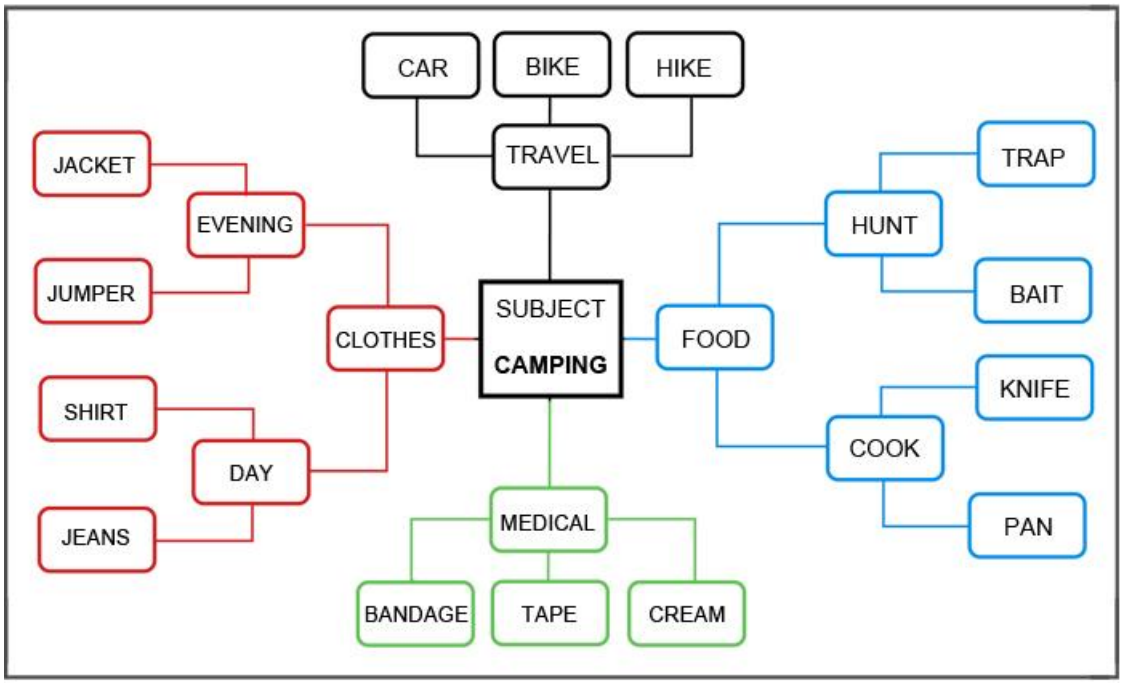


Figure 3: Concept Map showing subject nodes and related themes in order

The concept map according to Pui-Ian, (2009), is a diagram of many nodes each representing a key theme, of which each node contains a subject title for the theme in question, see figure 3.

These individual nodes are subsequently linked together in hierarchy with directional lines, which can also labelled for reference if needed, according to the connectivity in the data at hand. The nodes tend to be arranged in hierarchical order with the most important headings at the top and the least at the base. Concept themes can then be explored by branching off each node into areas which are related to the subject heading contained within the node. The user of the concept map can then be visually informed as to the relationships between any known elements of any given system, and trace the cause and effects of variables through the process of connectivity.

Within this research, concept mapping will be useful in exploring where each of the key subject headings for EIR with SMEs can be broken down into its various components.

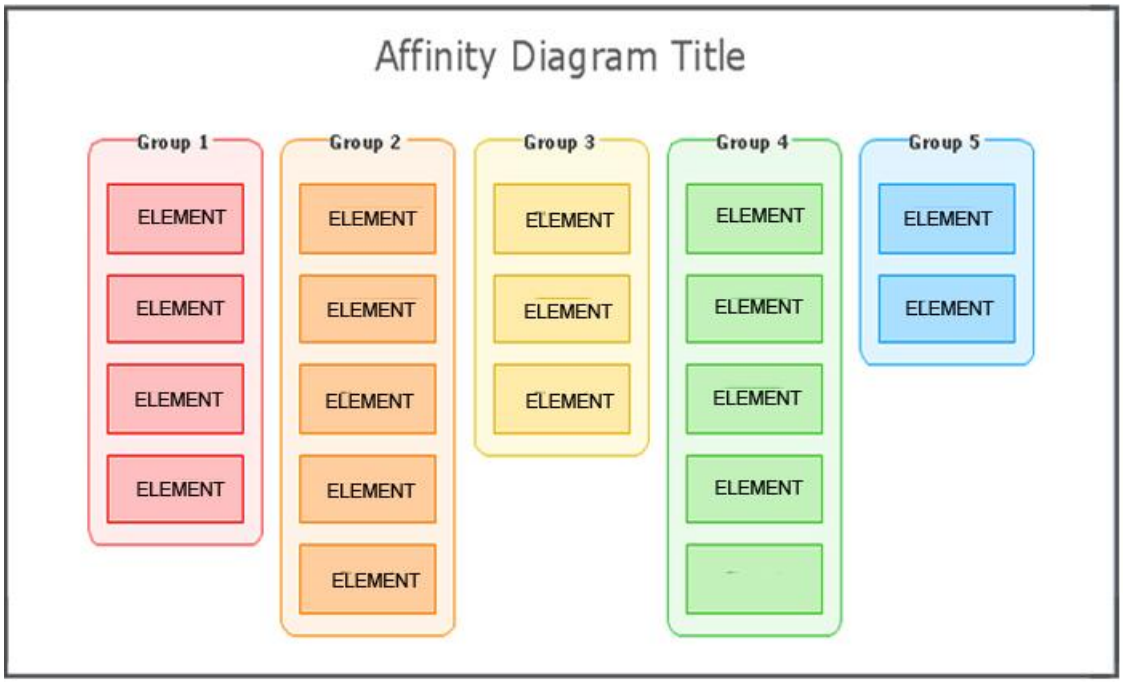


Figure 4: Affinity Diagram showing themes and elements placed in hierarchal order

These components can then be placed in order of importance for further focus and refinement of key themes during the research process. The concept mapping process by way of visual evaluation is similar to using the process of affinity diagram approach, when summarising the relevance of any gathered information.

Affinity diagrams as in figure 4, map information from insights or issues into hierarchical orders which can then reveal the scope of the problem being researched in a visual manner (Bishop, 1997).

Information gathered is grouped into various sections or sub sections of data, and then organised into hierarchical order. This enables the user to observe the various categories of the research subject and the relative elements of each category.

Once some order and hierarchy has been assigned to the key areas involved within EIR themes for SME's, a further process map technique can then be developed to demonstrate how these key themes operate as an overall operational system. Process mapping can then be seen as a way to identify and document the analysis and development of an improved process relative to any given area (Anjard, 1995).

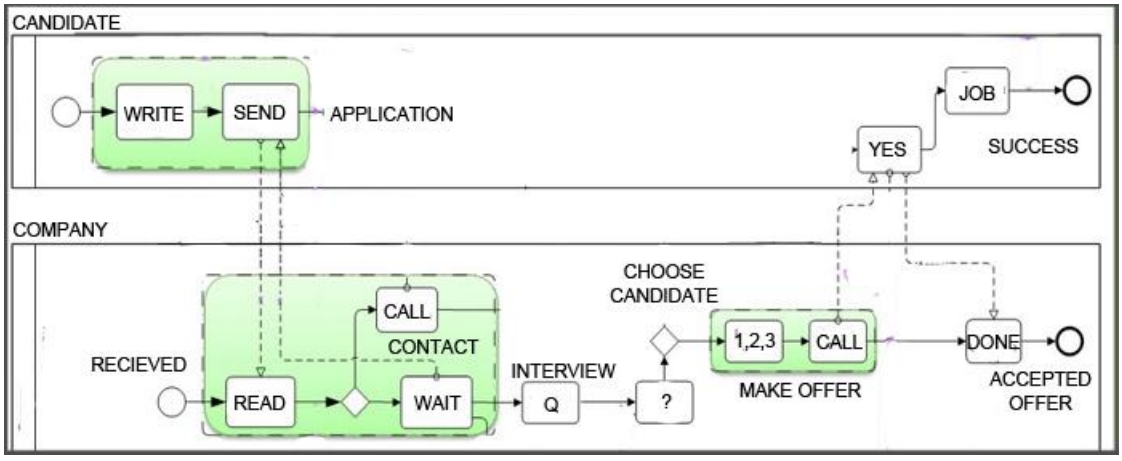


Figure 5: Process Map for the application process of a potential job offer, from application creation by the candidate, company selection process, to offer acceptance

The process map, as seen in figure 5, can be seen as a visual aid for pitching work processes which show how inputs, outputs and tasks are then linked to one another.

This is similar to the concept map although instead of placing elements in hierarchical order, elements are related to one another in order of operation within a known system.

This can prompt new thinking about how work is done and how tasks are carried out, enabling key themes to be visualised as a process of engagement and operation. Process mapping essentially will include the following:

1. Taking operational procedures and converting them to a diagrammatic.

2. Showing how inputs relate to outputs in any given system.

3. Showing the functions and departments involved in any given system.

4. Showing the connecting processes between key elements in any given system.

5. Enabling the user to highlight areas for improvement once mapped out.

6. Allow for the triggering of ideas to improve processes within the given system.

According to Anjard, (1995), process mapping alerts users to areas in which changing processes will have the greatest impact on improving quality, through visualising the complexity of the existing system. It is information overload which SMEs experience when disseminating the importance of EIR at actionable levels within organisations. This research aims to not only uncover areas of most importance for improvement within this sector, but also visualise these topics in a way which can be digested more easily. Additionally, working in this manner throughout the research programme, will help to structure research findings as part of a well-defined system diagrammatic.

3.9 Summary

The most appropriate research method has been chosen as Delphi. Using the Delphi method will enable the sequential and iterative process of data gathering which will be required to inform our key criteria for visual mapping of the subject area. Using Delphi method will also avoid the complications when working with the SME community, where lack of time and lack of resource create complications in making regular contact.

A mixed methods approach has been implemented to enable the exploration in developing a visual mapping process. This mapping process will be used in parallel to address and identify where key themes within the data holds significance for improvements within the SME sector. In essence each form of data from both

qualitative and quantitative approach will inform the other, to build context for the mapping process and overall key areas of concern.

In order to compensate for accessibility issues of working within the SME community, it is most appropriate to assign an expert panel as part of the Delphi method. The expert panel will be used to gather data and build theoretical frameworks for working within SME supply chains. This will be done in a sequential manner through iterations of discovery, analysis, design, review and improvement, to refine a workable resolve to the key issues defined within the literature review. In order for this to be achievable the expert panel must be chosen specifically to address all areas of SME involvement with environmental concerns, identified within the literature review.

Therefore, the criteria for the expert panel will need to include members who:

1. Have direct involvement within the area of packaging design and development.
2. Understand the implicit nature of the packaging supply chain, who operate within the chain, where these operations take place, and what actions are carried out.
3. Have direct involvement when working with SMEs, and the associated difficulties that an SME Company experiences.
4. Have an implicit understanding of the new product development process.
5. Have an implicit understanding of regulatory procedures and how these interact with the SME sector.
6. Have a broad range of practical experience and professional practice.

7. Have an interest in sustainability, EIR activities, and the improvement of best practices within this area.
8. Are able to periodically commit to reviewing and returning data as part of the iterative and sequential Delphi approach which this research requires.

In order to gain a broad perspective, industrial practitioners have been contacted from differing areas of the packaging supply chain. This is to ensure that the most holistic approach to resolving EIR problems for SMEs can be attained.

Industrial practitioners, who are involved within the iterative evaluation phases of this research project, demonstrate specialism within the following:

1. *Trading standards and packaging essential requirements (PER) regulations consultants.*
2. *Producer responsibility obligations and requirements (PROR) regulations consultants.*
3. *Packaging Federation and trade association consultants.*
4. *Industry Council for research on packaging and environment consultants.*
5. *Environmental consultants from Royal Bank of Scotland (RBS) services.*
6. *Packaging design and development consultants.*
7. *Packaging waste regulation compliance providers.*
8. *SME manufacturers from the food and product industries.*

The above panel members provide a well rounded perspective from each varied viewpoint of packaging design. The involvement of these industrial practitioners is essential for the design and development of the visual process mapping technique, guided by the Delphi method.

The next chapter will discuss the activities undertaken in attaining the key criteria for informing the industrial questionnaire. The steps taken are in line with the Delphi method which also assists in building an overall illustration of SME supply chain operations. This has been essential to identify where potential environmental concerns can be addressed by visual process mapping.

Subsequently, attention will be drawn to the selection process of key factors which further inform the direction of the research project. Finally, the industrial questionnaire will be presented and the justifications behind the required factors within it, for helping to inform the process mapping tool for SME EIR.

4: PILOT SURVEY AND PROCESS MAPPING DEVELOPMENT

4.1 Introduction

This chapter describes the research processes undertaken during the selection of appropriate criteria for the industrial questionnaire, which subsequently informed the eventual process mapping of EIR for product producing SMEs. Vast opportunity for improvement within this sector has been demonstrated within contemporary literature, where current studies have outlined the difficulties which SMEs face when dealing with the implementation of EIR activities and associated practices. With sustainability and product development being so contextually broad in application, the range of topics of which SME organisations must encompass can be a daunting and burdening task when time and resource is at a premium.

To illustrate the general complexity of problems which SME manufacturers currently face, an affinity diagram approach was used, shown in figure 6, to investigate areas of concern from the literature review and consider appropriate theme structures. Working spatially with complex data through mediums such as an affinity diagram approach, enables tangible engagement with the data and a practical approach towards discussion and direction within emerging research themes.

The left-hand side of image 'A' shown within figure 6, shows the process used to place the literature review concerns in a spatial manner to begin to physically engaging with the data. In essence this is a form of large-scale note taking, which enables the researcher to reorganise data in a way which provides a full overview of the research problem. This held merit for working spatially, but still lacked a clear visual order making it difficult to gain valuable insight.

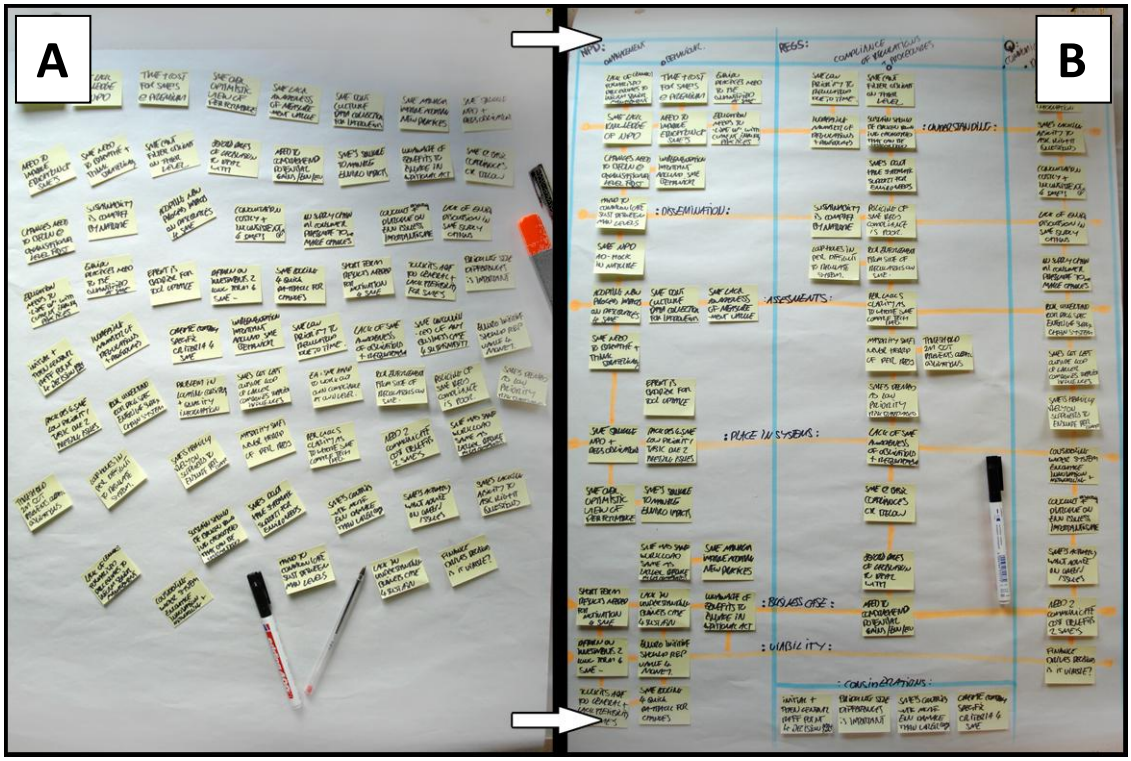


Figure 6: Affinity Diagram approach to organising all points raised within Literature Review, structured into themes and subsequent connections within the data

The affinity diagram approach shown on the right-hand side of image 'B' within figure 6, enabled the grouping of literature review concerns into categories and subcategories in a more structured visual manner. Working in this manner enabled further highlighting of where potential information crossovers were occurring between the data. This can be seen in the right-hand side of figure 6, where issues aligned vertically, share a connection across the three separate areas demonstrated within an affinity diagram.

Crossovers are useful to identify as they can demonstrate existing relationships between differing sets of data, which when considered in isolation may not always be obvious. Working visually also engages spatial memory and enables the placing of information to build associations within a defined system of operation.

The three main subject areas which were identified through the application of an affinity diagram are as follows, which reflect the main concerns as highlighted in the literature review:

1. An overall SME lack of basic knowledge and awareness towards product development sustainability, its related practices, and its relevance to the organisation. Most concern is focused around the design stage where management must make choices, of which 80% of these decisions create environmental impacts in one form or another.

2. The complex nature of regulation requirements for SME organisations and the subsequent poor adoption of these practices at an operational level, including the poor enforcement from external regulators.

3. Low levels of communication between SME organisations, suppliers and the regulation bodies within supply chain systems. This results in poor enforcement and poor adoption of sustainable practices; and the inability to ask informative questions in relation to EIR practices in NPD.

Using the affinity diagram approach shown in figure 6, helped to identify crossover themes within the data, which bridged each of the three main subject areas.

These are as follows;

- An overall lack of education and generic understanding ranging from internal NPD procedures, through to regulations requirements and the ability to engage in conversation and discussion around these topics within the supply chain.

- Inability to self assess NPD procedures against EIR measurements, with where and how to compile information unclear at SME management levels.

- A lack in understanding of where current SME practices have impacts upon the environment, associated consequences and what is currently available to reduce environmental impacts.

- Grasping the business case at management levels for EIR and the viability of such actions with potential returns.

The combination and complexity of these issues puts SMEs at a direct disadvantage, when needing to address EIR best practices within contemporary NPD. Due to the complexity of factors which SMEs face when dealing with NPD and regulations, proposals for improvement needed to reflect contemporary operational practices. Definition of operational practices would provide the boundaries for a visual mapping process to be placed into a direct context.

Therefore, objectives were set to engage Delphi panel members in discussion which would help to define the following:

1. To verify and define the key areas which SMEs commonly struggle, when integrating sustainability into current NPD. These verified key areas will be grouped into industrial questionnaires, to attain data in relation to key criteria for final mapping proposals.

2. To define overall system processes of which SMEs operate when engaging in NPD. This will need to include not only SME internal procedures for product development, but also the external supply chain procedures which include suppliers and customers within wider operational systems.

3. To define the overall extent of the government regulations and how these integrate with SME NPD structures. This will be essential in proposing a

method to bridge the poor levels of communication between the regulator and the SME.

The compiling of this data has enabled the development of appropriate questions for the SME sector, to elicit their current industrial practices.

4.2 Initial Ground Work and Data Collection

At the beginning of the data collection phase, little was known about the level of detail which would be required to build a sustainability process map for EIR. The experience was similar in context to an SME company starting out knowing very little about obligations and the channels of assistance which are currently available. This approach reflected the qualitative theory that the researcher 'does not know what he or she does not know', and is therefore being subjected to experiences for the first time.

Therefore, the initial steps were to go back to basics, to understand the area of packaging and product development from the ground up. This would ensure that any areas of sustainability which had not been covered within the literature review could be picked up early. Industry documentation intended for SME distribution and accessed through Envirowise, (now WRAP), provided the following information:

1. The breadth and depth of criteria essential for SMEs to undertake to improve their environmental credentials.

2. The way in which information is presented to the user and the clarity of procedures.

The Envirowise program was aimed specifically at businesses who desired to improve their resource efficiencies to save money, self educate in regards to better practices and reduce their impacts upon the environment as a result. Advisory format is PDF

documentation supplied online. This contains a comprehensive range of information covering topics such as eco-design and packaging through to the specifics of management; materials, design tools, wastes and disposals; and some indication towards the potential of cost savings.

Although the document is visual in places and does use some system diagrams in relation to industrial practices; overall presentation is still text heavy and requires significant amounts of reading for overall comprehension. An example is shown in figure 7 below.

Figure 7: One example of the text and bullet point heavy documentation provided for SMEs in assisting them with understanding their obligations and requirements.

The current formatting separates the topics from one another, with no central reference point to draw relationships between the embedded value and NPD processes. This creates a sense of a lost opportunity, where even the NPD guidance is contextually separate from the rest of the brochure value, as seen in figure 8.

Although laborious in detail, the Envirowise documentation did provide a comprehensive list of subject headings to consider when dealing with packaging

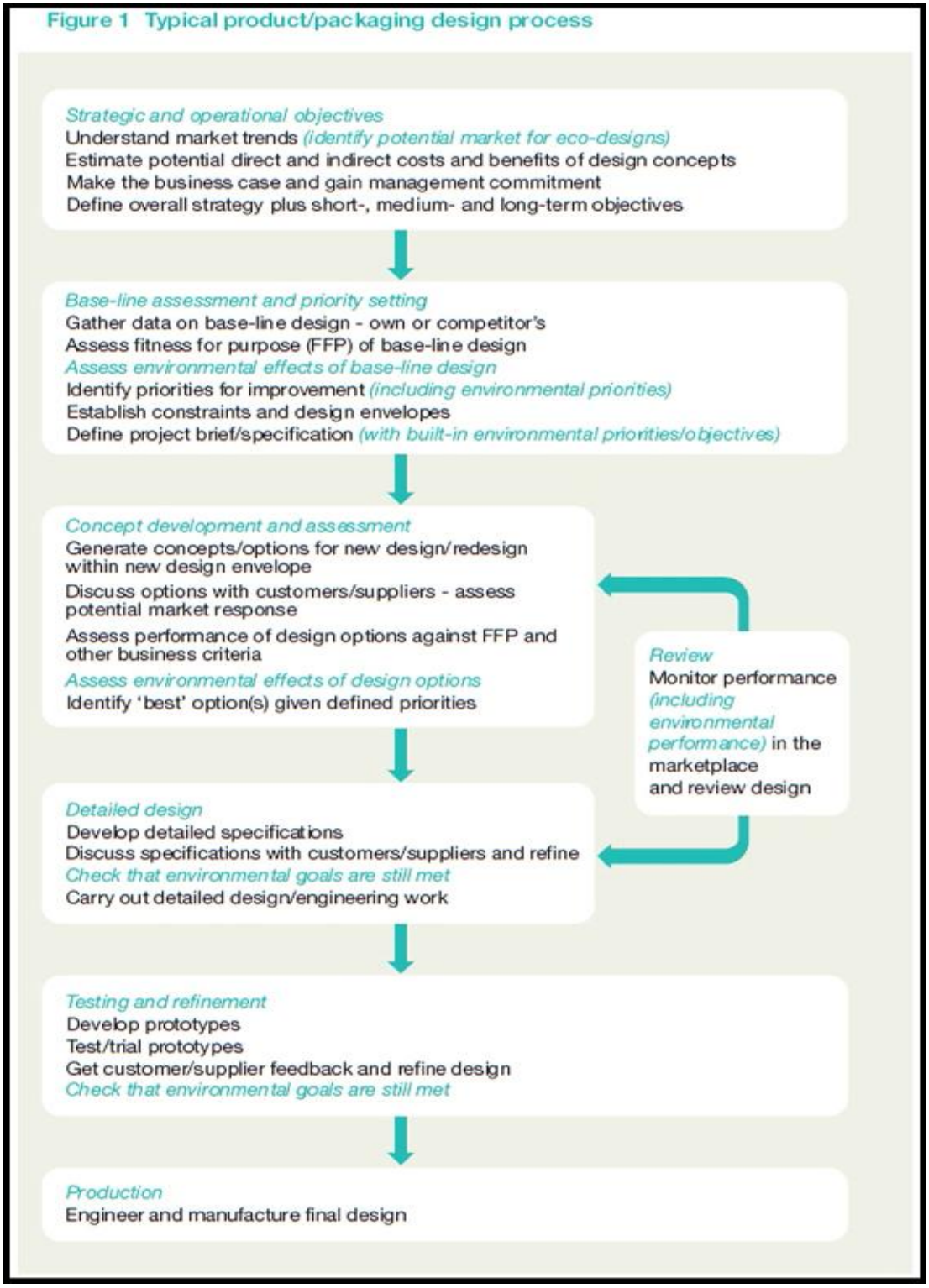


Figure 8: An example process diagram within SME documentation from Envirowise, which bears no connectivity with any additional sustainability information contained.

sustainability, EIR and new product development. An overview of these main subject headings contained within the Envirowise documentation encompasses the following:

- *Transport efficiencies and the utilisation of space during transits.*
- *EMS (environmental management systems) frameworks.*
- *Resource efficiencies and cost reductions through improved manufacturing.*
- *Materials properties, variations of potential uses, alternative approaches.*
- *Software and toolkits for the implementation of material reduction.*
- *Regulation procedures, types of regulation and types of governing bodies.*
- *Wastes disposals, recycling and reusing, LCA life-cycle assessments.*
- *Packaging design, creation utilisation materials and resources, fitness for purpose and design specifications.*
- *Supply chain counterparts, those who are involved and their purpose.*

The above list of criteria from the Envirowise documentation shows the broad range of tasks which SMEs need to manage when adhering to sustainable best practices. Justifying engagement for SMEs comes down to where associations can be made with the data and identifying relevance within the organisation. Therefore, how do SMEs identify information which is relevant to address their individual requirements, without devoting lengthy periods of time to inquisition? Additionally, it was clear that some levels of prior knowledge or experience is required, to interpret the key terms and phrases used within the document; while the delivery format in PDF isolates the reader from working dynamically with others.

Contact with Envirowise was attempted by post and email to discuss the key points from the literature review, highlighted within the affinity diagram (see appendix 1.1). While waiting for a response, an initial questionnaire was drawn up to begin discussing themes with Envirowise which would be most suitable for the pilot

industrial questionnaire, (see appendix 1.2). Although this exercise proved useful in confirming subject headings for the questionnaire, the true complexity in posing the right questions became obvious due to the many topical areas to cover in SME EIR.

4.3 Initial Process Map Template

A key question at this stage was how to place findings from industry into a context which was descriptive and engaging. It was decided to begin process mapping the research area to visually demonstrate information obtained from working with external practitioners, to further refine the authors proposed approach. This initial mapping phase would need to focus on the three key areas which had been defined within the affinity diagram, but in more detail to expand the subject area:

1. Internal systems of packaging specification for SMEs. This would include the processes which SME management would navigate when choosing to bring new packaged products to the marketplace. Specification procedures related to the design and decision-making activities within the organisation and the levels of communication with external partners during development. As mentioned before 80% of environmental impacts originate from the stage of design so crucial decisions made during specification are ultimately responsible for long-term environmental impacts.

2. External systems of supply chains and demand for product producing SMEs. This would include the processes involved in working with external partners who are manufacturers, stakeholders, purchasers and customers which have an influence on decision-making and logistical systems. As SMEs are small in nature, it was essential to understand where they demonstrate an influence within a wider operational system.

3. External systems of regulation procedures and enforcement policies for all companies. This would include all legal parties which have an influence upon the design and development of product packaging and how obligations interrelate with the existing supply chain systems. With the complex systems of product packaging, it was essential to understand not only the problems faced by SMEs, but how regulations subsequently operate.

This led to the building of an initial process map as a vehicle for discussions with industry, within these early stages, enabling refinement of the overall principal behind visual delivery of information. Only the most essential criteria would be required within the final process map for SME EIR, to address the most pressing issues needing immediate attention.

4.3.1 Packaging Federation

It was thought that Envirowise would make a useful research support/participator, after reviewing a number of their publications, but after three attempts to contact them with no response it was decided to look to other industry professionals involved with packaging SMEs. The approach was to locate an industry professional from within the Packaging Federation who could confirm the key areas required for discussion on SME sustainability topics. The Packaging Federation describes itself as a unique representative body for companies and organisations in the UK packaging sector and any associated activities. Its role is also to provide a balanced picture for the role of packaging in society and to lobby for a balanced debate on its worth and environmental impact. In pursuing this, the Packaging Federation has regular and vigorous dialogue with Government, politicians, media, supply chain partners and the wider public. Although the strategy of the Packaging Federation appears to be more of

a promotion for packaging, (considering that it lobbies for balanced debate on its worth rather than the reduction of packaging altogether), it was decided to try and initiate neutral but informative discussion. So as not to overburden any correspondence that was kindly provided by the Packaging Federation, the previous questionnaire was summarised into two key points. This was to enable the cross referencing of response, against points raised within the affinity diagram. Any correlation between points highlighted would help to define initial key criteria for later discussion with panel members.

Both questions focused on the positive and the negative aspects of SMEs engaging with EIR. The aim was to obtain a rounded view of issues which needed to be addressed. The two questions asked of the Packaging Federation were:

1. Which current factors encourage SME companies to investigate more sustainable opportunities in product development? The aim of this question was to highlight any tangible benefits for SMEs to invest precious time and resource into the self education of sustainability.

2. What are the problematic factors for SME companies when adopting and taking on board new sustainable strategies? The aim of this question was to clarify the challenges which are presented to this sector when engaging with sustainable practices and the hurdles which must be overcome.

Identifying the basic challenges and incentives helped to inform how the mapping process would be framed in a way which is, forgiving where difficulty is presented and encouraging where incentive is required.

A number of points were raised in relation to the two questions above, a summary of the transcript (see appendix 1.3), is as follows:

- SMEs are currently finding it difficult to obtain basic advice which can steer them in the right direction, and a resource is needed which tackles this.
- Terminology can be an issue for SMEs when working within the complex area of packaging.
- SMEs need to be able to recognise their own competencies and understand what they can potentially do.
- SMEs need to be able to ask simple questions to steer themselves in the right direction.
- SMEs struggle to understand their place in wider systems and what is actually available to them on a grander scale.
- A checklist would be of benefit when working with suppliers, to help address some of the fundamental questions for SMEs, such as regulations etc, specification criteria.
- If packaging is badly specified, there is most likely a breakdown in the interface between the supplier and the purchaser due to not asking the right questions.
- SMEs may not actually be aware of the benefit which could accrue from some sensible choices for asking some obvious questions during development.
- It is most likely around 95% of SMEs have never heard of the packaging essential requirements regulations (PER).
- SMEs often don't realise the potential which is available to them.

After discussion with the Packaging Federation via phone conference, it became clear that SMEs have much potential, but lack the basic practicality to put this into practice.

If SMEs were more aware of the opportunities which were available to them they may be encouraged to take action to improve their education. But, currently they do not have the basic competency to ask the basic questions which could lead to further improvements.

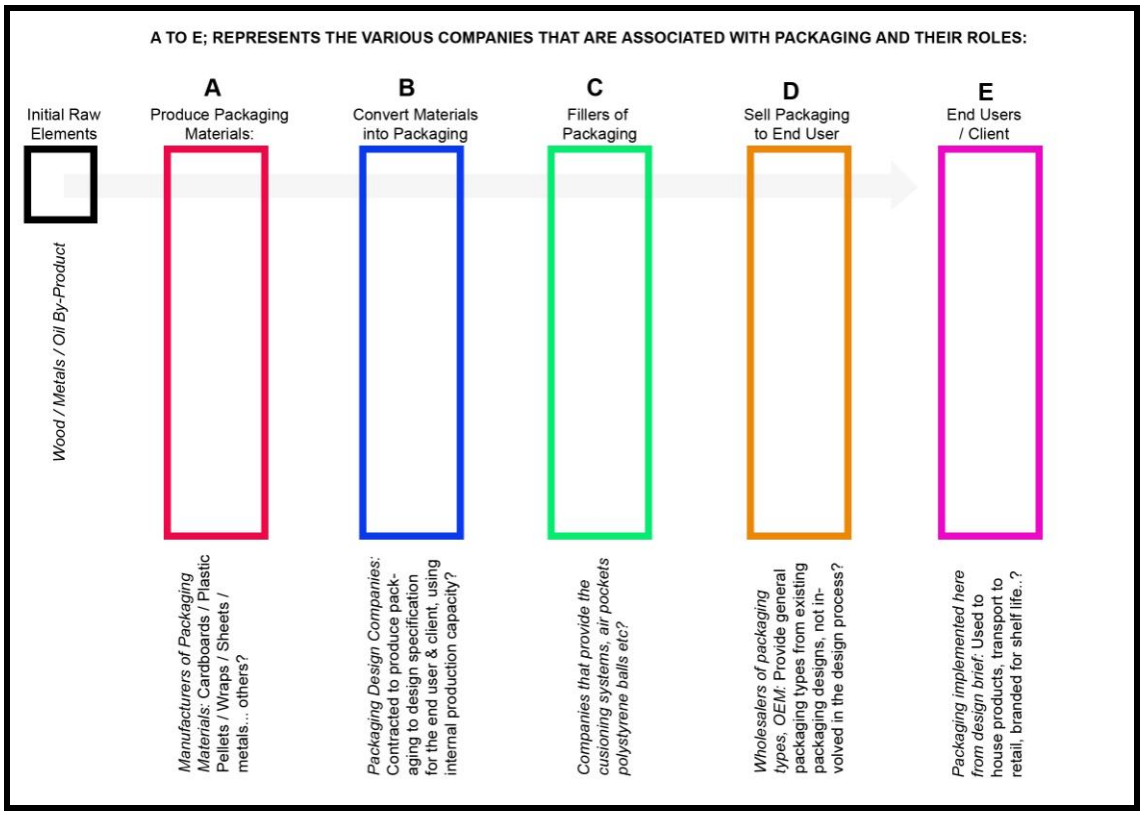


Figure 9: Initial process map indicating the order of packaging supply and the key organisations which operate throughout packaging specification and development.

While this discussion did not directly provide information required for defining an SME supply chain map, it did indicate the need for an improved method of delivery for environmental information.

To begin placing the emerging issues in context with one another, an initial visual process map was put together to lay out the packaging process as a whole, with each step in the packaging supply chain in chronological order, shown in figure 9. This became the first major step in the creation of a visual mapping process, which

demonstrates the processes at play and how they relate to one another during the packaging specification process.

4.3.2 Mapping Development

The map in figure 9 provided a simple template where emerging issues in relation to SME NPD, could be assigned to corresponding locations within a diagram of packaging logistics. Although rudimentary, this provided a way to visualise clusters of emerging issues against their relative physical location, to enable discussion and further focus. Points "A" to "E" highlighted the main players within packaging development and a summary of the activities at that particular point of the process. Laying out each operation from left to right enables the user to clearly define the various stages involved, to gain an appreciation of the numerous phases which must be considered when engaging with packaging development. Although generally descriptive, this mapping process fails to incorporate the wider systems of regulation and also the detailed flow of design and specification between areas "A" and "E". Also, no placing of the SME within the wider supply chain logistics is present with larger competitor organisations.

The intention had been to maintain contact with a single industrial professional, to cover the ground work required for asking more informed questions to a broader professional panel. Elicitation of detailed responses requires provision of clearly focused questions. Unfortunately the rudimentary knowledge displayed on behalf of the research at this stage did not offer an incentive for any further engagement at this time from the Packaging Federation. The Packaging Federation explained that it was very difficult for a research programme to engage with the complex issues of sustainability, without having a fairly detailed knowledge of it to begin with. The Packaging Federation declined further support at this point saying that they did not

have the time necessary to provide a good grounding in how this industry currently operates, and terminated any further communication (see appendix 1.4).

This highlighted the Packaging Federation's recognition towards the complexity experienced when dealing with sustainability factors, which prompted the question:

If an SME was in the same position, how are they supposed to begin informing their practices when they too possess a rudimentary level of knowledge?

4.4 System Refinement and Modes of Operation

It was decided to use the initial process map to reach out to the wider professional community. The objective here was to use the first map to initiate discussion around the illustrated processes and where common issues for SMEs relate. The objective here was to make contact with at least six industrial professionals from differing areas of packaging sustainability for SMEs, who could discuss the areas defined when working with the Packaging Federation, and former affinity diagram findings. Professionals were chosen as a best fit to the areas defined within the first diagram:

1. Packaging designer: working with SMEs directly when dealing with the design of packaging. This would elicit an outside perspective on the types of difficulties which SMEs face when seeking help and advice. Grouping these issues presents key factors for SME organisations which need to begin dealing with packaging specification independently.

2. Privatised Environmental law consultant: working directly with SMEs in regards to their obligations and requirements set by the government. This provided an external perspective on how SME organisations are dealing with

the regulation system. Beginning to understand the dynamic between SMEs and regulators would indicate the levels of communication currently at play.

3. Packaging manufacturer: working directly with SMEs who could offer some insight into how standardised specification processes are manifested between both parties. This assisted in building the overall processes of how the packaging supply chain operates and where the SME companies sit within it.

4. Packaging research Council member: working directly with SMEs, who could offer some insight in regards to where process improvements are required.

5. Packaging and environmental consultant: dealing with all matters which SMEs would encounter, supply chain logistics, waste disposal and regulations, through to life-cycle assessments and carbon footprints. Working with an organisation which deals with the life-cycle of packaging would provide a solid overview of the processes involved.

6. Regulations officer for governmental compliance: being able to obtain information from a consultant within this sector would inform the boundaries which surround the whole packaging chain system. Understanding where governmental regulation intersects with packaging development would assist in the development of a mapping method rooted in current practices.

In order to break the overall packaging system down into its various components, and place emerging issues into context with the existing supply chain, initial process mapping needed to include the following three subject headings.

a) *Overall supply chain operation;* defining who does what and where this is done from initial material extraction to eventual disposal and recycling of materials.

b) *Design and specification;* to place into context the design activity, where packaging design actually takes place, where responsibility lies for ensuring quality and the various options which are available to SMEs.

c) *Government regulations;* to understand the major differences in types of regulation and how these obligations affect the various parties which operate.

4.4.1 Overall Supply Chain Operation

After consultation with the external panel, the following characteristics of the packaging supply chain were identified and laid out as below in figure 10. The packaging supply chain can be broken up into five main headings, starting from the introduction of raw materials through to the initiation of customer contact.

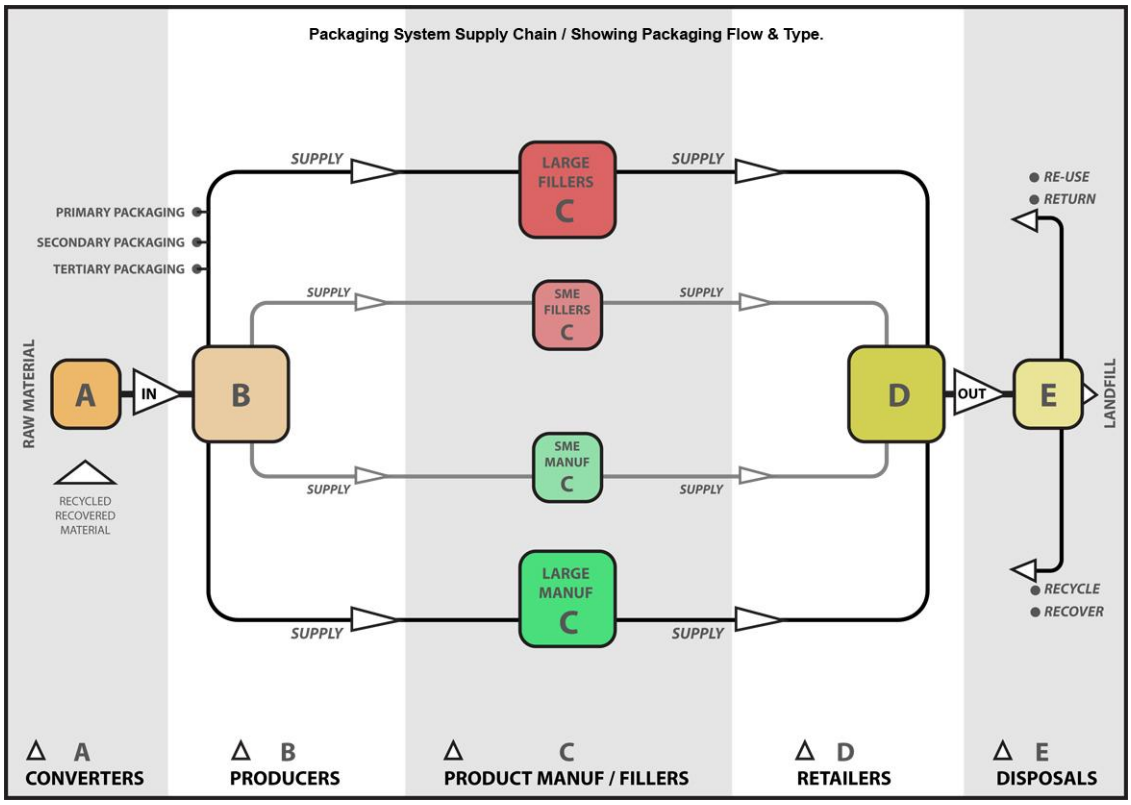


Figure 10: Showing the main organisational sectors and the direction of packaging supply between them, from initial raw material introduction, to final disposal.

The process map in figure 10 demonstrates these stages from left to right, including the key companies involved and the direction in which supply chain systems operate between them. At this stage the development of the map only demonstrates those which handle packaging once it has been developed, and currently excludes any design process or interaction with regulations. The terminology and stages involved are as follows;

A. *Converters;* being a converter of packaging material includes both the manufacturers of the packaging raw-materials and subsequently the producers of packaging "B", who turn the supplied raw material into a specified packaging product on behalf of the product producers "C".

B. Producers; packaging producers manufacture packaging on behalf of the client "C", "D", either through using stock ready product, or by custom specification dictated by the client product producers and packer fillers "C".

C. *Product Producers & Pack-fillers;* the pack-filling activity encompasses any organisation which supplies a packaged product to the marketplace following on from manufacture. Pack-fillers can be any sized organisation from large multinational organisations, down to local SMEs and can range from: food packers of food produce who use imported-packaging; product manufacturers such as consumer goods and electronics; and retailers "D" who sell their own-branded goods, such as Tesco’s.

D. *Retailers;* any outlet that brings in a packaged product and places it for consumer purchase.

E. *Disposals;* Reuse, Return, Recycle, Recover, Landfill of materials at end of the supply chain.

The areas mentioned above for the order of packaging supply were defined as per the correspondence from the external panel, via phone and email correspondence. Once plotted, the research could begin to engage with the key components and key stages from a holistic point of view.

4.4.2 Design and Specification of Product Packaging

The next stage was to use further information provided by the external panel via phone and email correspondence, (see appendix 1.5), to include the specification procedures between all parties. Including the specification procedures helped to understand who has the design responsibility during packaging creation. Understanding where the design responsibility sits between the SME, supplier and regulator, presents the opportunity to consider issues at both a micro and macro level.

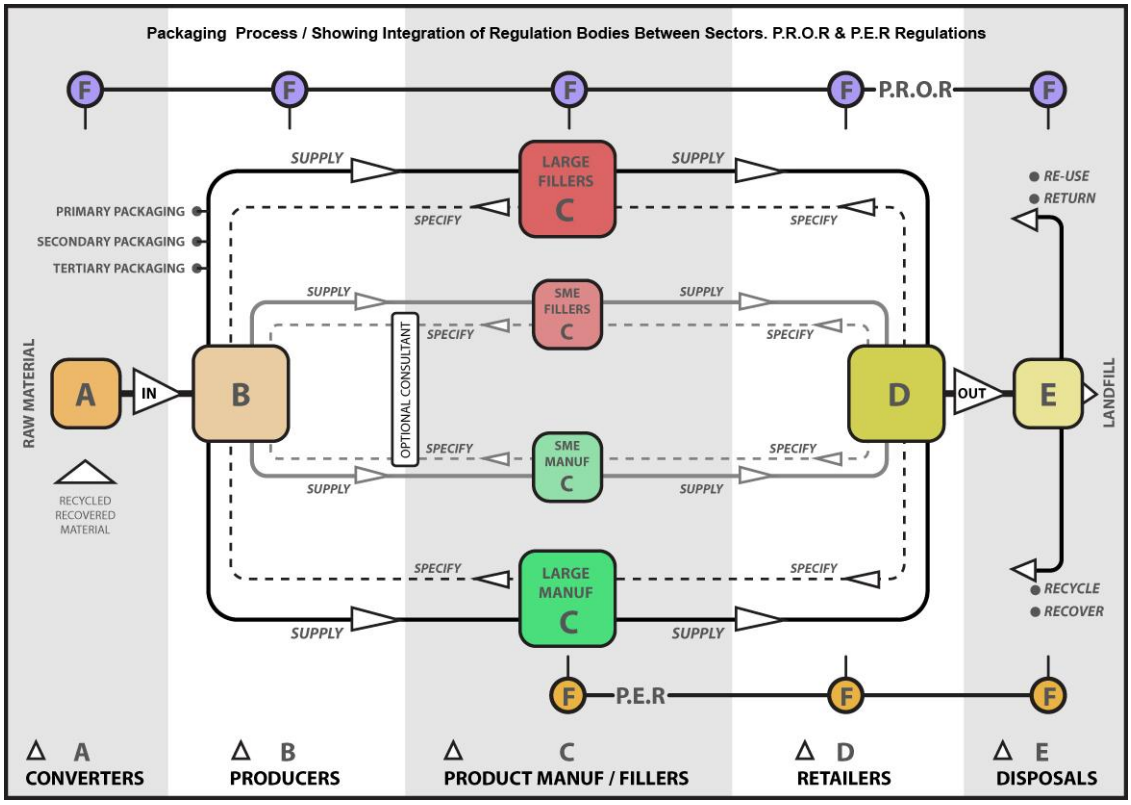


Figure 11: Showing the flow of packaging design and specification, and also the interaction of both regulation bodies throughout the current supply chain.

The more detailed process map shown in figure 11 additionally includes the flow of specification from all parties within the supply chain towards the direction of the packaging producer. Where SMEs are concerned at the centre of the diagram, additional consultants may occasionally be used to work on behalf of the SME to obtain the most optimum results where knowledge is lacking at an SME management level. The process map in figure 11 also demonstrates where the regulation bodies interact with each stage of the packaging process.

As mentioned within the literature review, the PROR regulations shown at the top of the map in blue, impact on every stage of packaging development, being that they are primarily concerned with the management and disposal of all wastes produced. The PROR regulations dictate that each member of the supply chain when dealing with packaging must deal with their obligated percentage of waste.

PER regulations are concerned with the design of packaging, shown at the bottom of the map in orange. Responsibility is placed upon those who actually place packaging upon the market. This is usually the retailer but also includes the product producer. This makes the product producer ultimately responsible for the packaging placed upon the market, and so it is the SMEs responsibility to ensure that all criteria for the PER regulations have been met accordingly.

Packaging design and specification can happen at various stages along the packaging supply chain and has no one-fixed mode of operation; but depends mostly upon the purpose of the packaging type, and the type of company size involved. Design and development could be specified at the stage of retail by product developers; by packaging producers; or by a subcontracted design team or packaging consultant working in parallel with the strategic goals of the company.

The variation in potential application of practices demonstrates a difficulty in designing systems which cater for all types of companies in all types of situations. As mentioned previously, one solution that works for all companies may not in practice work for many due to so much differentiation.

To explain where essential criteria originated for the eventual industrial questionnaire, the specification process for each sector of the packaging chain will be explained and will eventually focus on SME's and the problems of which they face. All information was obtained from working with external panel as a collective, and assisted in deriving the points of focus with which the industrial questionnaire would need to address.

4.4.3 Packaging Producers: B

Packaging producers, shown in "B", figure 11, rarely have one set path of operation that they work within and the project flow is normally dependent on what is required from the client. Packaging producers normally work to a brief that the customer will supply, this brief is usually researched by the customer and their advertising agency before being proposed to the packaging producer. This is particularly the case when working with large client product manufacturers, situated in "C". Once a concept has been put forwards the packaging producer will get their in-house team involved to consult on the proposed design and pull together technical drawings using CAD / CAM computer software, a prototype is usually made so that the customer can get a feel for the product before committing to tooling which is expensive. This indicates why it is difficult for SMEs to have leverage within current supply chains, when their orders may not be large enough to justify investments of time and resource from the packaging producer.

In light of material processes which are available to clients when designing new packaging, some packaging producers may offer a range of more sustainable choices and alternatives; these may be akin to the following;

- PCR, Post Consumer Re-grind (recycled plastics for re-mould).
- PIR, Post Industrial Re-grind (production recyclate for re-mould).
- BIO, Degradable.
- PLA, Polylactic Acid.

Even though the packaging producer may have these alternatives to choose from, the likelihood of application will normally be down to the customer to dictate rather than being ‘advised’ or recommended by the packaging producer. This will mostly be dependent on the strategic goals of the organisation, and the extent of the policy which is applied to that particular packaging product. Some stigma exists around use of recycled material in new packaging which puts some companies off from specifying PCR during new packaging developments. Additional material reduction approaches are particularly useful for deciding what type of disposal is required of the product packaging. If the packaging has no re-use potential and must be a one-trip solution to landfill, minimising packaging material must be at an optimum to maximise EIR.

Finding the right balance for designing packaging that is fit for purpose, as in line with the PER regulations, is essential for EIR. But for SMEs who are unaware of such activities, packaging design will most likely be over or under specified, and therefore incur higher financial and environmental impacts.

4.4.4 Large Product Manufacturers: C

Large product manufactures, more often than not will have their own in-house packaging technologists, or cross departmental teams. These teams will develop appropriate packaging designs in relation and accordance to the product being placed upon the market, and in line with the strategic policies of the company and additional stakeholders. Packaging will most likely be developed alongside the product itself as part of the design process in parallel. This will incorporate iterative design development, which encompasses: style, cost, price point, compatibility and periodic consumer testing.

Being larger in nature, more resource can be invested in adhering to PER regulations and ensuring packaging design is optimum and cost efficient; but additionally they are under more scrutiny. This place more pressure on larger companies, but with SME organisations being typically small, many SMEs simply slip through the net when it comes to general compliance procedures.

External design companies may be occasionally contracted into the design process to give perspective on structure or brand representation which will then be fed back into concept refinement. Contracted packaging producers can then be brought in to begin prototype modelling phases on behalf of larger product manufacturers. These companies typically have much more resources available at their disposal than small SME companies, with more influence upon the supply chain due to the volume and size orders of which they place. It is also more likely that larger companies will have much more diversity in knowledge than the smaller SME organisations and will be able to dictate with confidence the exact specification of which they require. Smaller organisations without this level of influence may not have the flexibility in approach to that of the larger organisations and ultimately get left out.

4.4.5 Retailers: D

Large retailers of packaged products, who place packaging onto the market for consumer purchase, will have a number of modes of operation depending on the type of product which is packaged. Large organisations will have their own in-house team that will specify the minimum requirements that packaging must adhere to before being shelf ready, it will then be up to the product supplier to exceed these requirements. The specification requirements will be based around cost, size, weight, space optimisation, transit, material type and if the product can be shelf ready or not.

Given the size of retailers, their options may be restricted, depending upon constraints which may exist such due to the manufacturing processes which are involved further down the logistical chain. It may simply not be cost effective to invest in new automated packaging for different specifications, when current systems are already operational and set in stone for current packaging specifications.

4.4.6 SME Manufacturing Companies: C

According to the external panel, sustainable supply chain management is becoming much more important with the introduction of new processes and materials at various stages. This makes the monitoring of sustainable supply a tricky business. It can be difficult to determine whose job it is to ensure design responsibility as the level of control will depend on how much organisations actually can and want to make an impact on things.

Where the responsibility falls on the SME, companies typically do not have the grounding knowledge to be able to ask the appropriate questions of the supplier to push the boundaries of quality. Also SMEs typically have the perception that what is

being provided by the packaging supplier is necessary and to the best specification possible, within the capabilities of current manufacturing.

SMEs do not typically have the luxuries that larger companies can afford during packaging specification, such as; packaging technologists, advanced manufacturing processes or greater influence on suppliers. As a result, SMEs are typically dependent upon their packaging component suppliers to offer advice and support in all areas, meaning that their design options and purchasing power are limited. In certain circumstances small companies may follow the lead of larger companies and use off-shelf packs and standard packaging from companies such as Rexam and Smurf Kappa. At times they may approach their packaging producer for possible design input if they wish to improve product packaging for a unique or bespoke product.

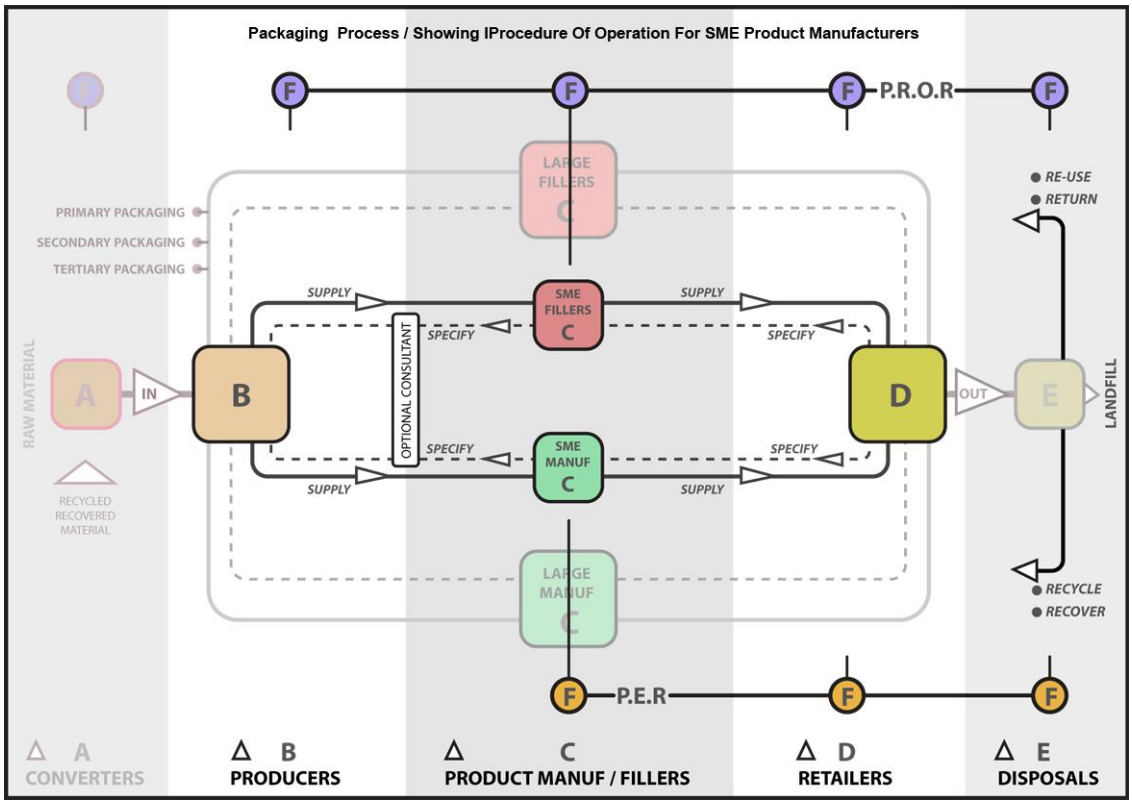


Figure 12: Showing isolation of SME manufacturers working within a separate supply chain loop, to larger organisations which have more influence on suppliers

According to packaging consultants, manufacturers of packaging components will have detailed expertise within a niche packaging area, but will rarely offer advice or solutions which work outside of the services which they currently offer. This means that SMEs who place the design responsibility into the hands of the packaging producer could be compromising potential improvements, through the limitations of supplier creativity and production processes currently set in stone.

Typical discussions between SMEs and suppliers will mainly revolve around the optimisations of cost, which as a driver for decision-making is influential, but will rarely improve the scope of choice which is on offer to the client.

Scenarios such as this indicate that sustainability is becoming a side stepped issue in place of costs as the main focus. This of course is logical, but research indicates that there are many potential cost savings which can be obtained through improved sustainable practices, it is just that the channels of discussion in regards to these are currently being neglected.

As packaging producers have the potential to develop innovations of one sort or another; typically it is left to the SME client to decide upon their own policy of what is required, and on what basis the importance in development lays. For SMEs who may lack in the capacity of knowledge and to specify their own requirements, alternatives and potentials that do not get advertised freely, will go unnoticed and potentially leave the client at a disadvantage.

Another alternative to improve packaging efficiency may be that the SME can involve the assistance of a packaging consultant or design consultancy, shown in figure 12 at the centre of the diagram. Where discussions involving new packaging design have been unsuccessful when working with the packaging suppliers, consultants can take

over with additional advice ranging from brand and livery; through to packaging structure and material.

Depending on the quality of service provided by the consultant, questions are asked of the SME clients to determine exactly what they are looking for and the strategic goals of the company. The strategic goals of the company will help the consultants to define the priorities which need to be included with packaging specification, whether it be brand, sustainability, disposal type or purely the reduction of costs'. Consultants usually begin working with suppliers in parallel with SMEs to determine the feasibility of completing the orders, which are generally more fit for purpose and appropriate to the client's needs as a result of this negotiation.

This in effect demonstrates how consultants when working on behalf of the SMEs, are well versed in understanding the importance of asking appropriate questions and on where to place design priorities. It is this same level of proficiency of knowing where to place priority and asking informed questions at the design stage, which would be of huge benefit to SMEs, if these same core values could be bred at a management level.

Additional help from contracted consultants will invariably put more pressure on the packaging producers to work outside of their current capacities if they wish to retain the business. In less satisfactory situations, the SME may take the opportunity to find new, more compliant producers in line with their own objectives. According to packaging consultants, the biggest problem that SMEs currently face is a typical isolation within their supply chains as shown in figure 12. This then presents a where to go, and what to do scenario when contemplating new processes.

Because there is currently no singular system of updated information, SMEs remain isolated from any new innovations which are developing within current packaging manufacture. They are also typically unaware of the services which packaging

consultancies can offer, and the benefit that these services may have. Although, attracting business for packaging consultants tends to be a bit ad-hock, with consultants admitting that large numbers of SME businesses are unaware of how to find them, or what benefits they can offer.

The interesting component is that although smaller companies may have less capacity and influence in comparison to larger more resource abundant companies; the flexibility to change suppliers, design direction and process procedures is actually greater with SMEs. Typically, SMEs are by far more manoeuvrable than that of their larger counterparts, but they are simply unaware. This lack in understanding of the potential that SMEs actually have is significant, and this is a major benefit to design consultancies when and as they are approached.

Packaging consultants have stated that it would be of a huge benefit if SMEs were able to specify their own sustainable criteria, prior to engaging with discussions. This is also a reflection of the comments which were provided by the packaging federation; where they felt that SME organisations would benefit from a system which enables them to pick and choose topics for discussion when working with others.

If SMEs were able to specify requirements, not only would this assist consultants in defining what was effective and possible for the client, but it would also put greater pressure upon packaging producers to conform.

4.5 Industrial Questionnaire Essential Criteria

Delphi panel correspondence helped to define the overall packaging supply chain operation for mapping use, and subsequent factors for concern with SME practices.

Three questions were subsequently proposed to the entire Delphi panel, which were derived from the cumulative points raised in section 4.4. The aim of these three questions was to achieve focus for the industrial questionnaire. These questions were:

1. In your professional experience, where would you say that the most essential improvements are required within packaging sustainability, which are currently a challenge for SMEs due to the lack of resources and inherent knowledge?

2. In your professional experience, what would you say are potential limitations within the existing supply chain networks for SMEs, in terms of improving packaging sustainability at a management level?

3. In your professional experience of packaging sustainability, what would be the financial benefits for SMEs to invest in improving it, in terms of production and process, or available cost benefits?

These questions were posed to the expert panel via phone and were kept semi-open in terms of response to allow additional opinion to be expressed alongside questions posed (see appendix 1.6).

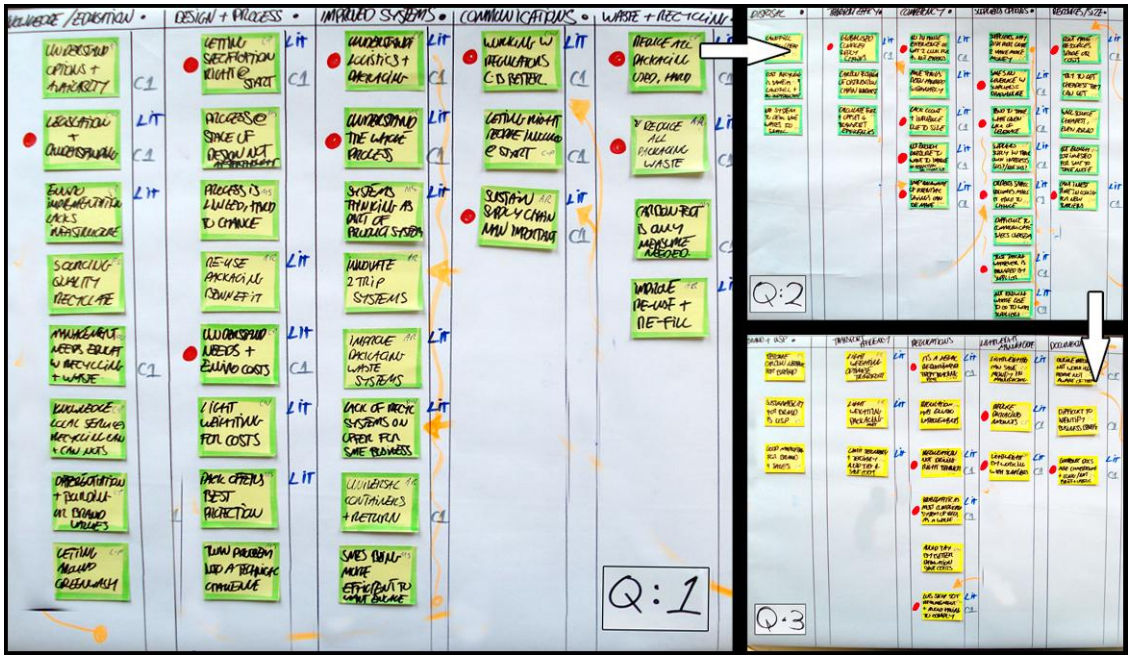


Figure 13: A new affinity diagram covering the three questions asked of the external panel in relation to management and sustainability problems for SMEs.

A combination of both affinity diagrams and process mapping were used to highlight the points raised by the expert panel and assign the location of these points within the existing visual process map system. As a combination, these visual methods were used to define the factors of importance for the industrial questionnaire.

As can be seen in figure 13, the affinity diagram proved useful in gathering the collective input from the external panel into categories and subcategories. This process was repeated for each of the three questions asked of the panel.

Red dots were placed next to issues which had arisen within the previous affinity diagram from the literature review, and also any initial discussions when building the overall system process map. This begins to show the commonality of issues which are repeating throughout the data while being gathered through numerous sources. This helped to indicate where the potential focus for the industrial questionnaire needed to be considered.

A summary of the main findings where responses were common throughout each of the three questions are as follows:

4.5.1 Question 1

In your professional experience, where would you say that the most essential improvements are required within packaging sustainability, which are currently a challenge for SMEs due to the lack of resources and inherent knowledge?

- Knowledge and education is still a critical issue for SMEs. Not only with understanding obligations from a regulations perspective, but also what options are available to SMEs. This includes: who to go to and what to ask; how to locate good quality advice and direction when it comes to management of packaging sustainability; and how to build brand values which effectively represent the business and its strategic objectives.

- Internal and external processes leave much to be desired. This is with SME management's understanding of sustainable logistics for packaging, but also from the side of specification and potential cost benefits of more efficient packaging design.

- Education of better systems and the value which can be obtained using recycling and recycled materials, is an area which needs addressing simply due to the lack of perceived benefit of engaging with such activities.

4.5.2 Question Two

In your professional experience, what would you say are potential limitations within the existing supply chain networks for SMEs, in terms of improving packaging sustainability at a management level?

- Internal competency of SMEs is lacking due to poor education and awareness of available options. An inability to ask the right questions or knowledge of where potential savings could be attainable from improved resource efficiencies or changes in procedure.

- Cost is still too much of a driver for companies to consider alternative options. SMEs essentially will choose the cheapest and quickest way around the problem unless alternatives can be demonstrated within a time period which is tangible and beneficial. Where the communication and importance of improvements is not shared with the SME community, there is little incentive from a management perspective to invest time and resources into, what is essentially perceived as, green-wash.

- Working with suppliers and the barriers to communication are a major issue here. Suppliers are only operating within their own interests rather than negotiating with SMEs. This is due to suppliers being of the opinion that SMEs struggle to understand the complexities of packaging specification. As a knock-on effect, transport efficiencies could essentially be improved with better collaboration between suppliers and SMEs, which would essentially improve disposal systems and overall carbon contributions.

4.5.3 Question Three

In your professional experience of packaging sustainability, what would be the financial benefits for SMEs to invest in improving it, in terms of production and process, or available cost benefits?

- Essentially it is difficult to identify where the business benefits are especially for those with poor knowledge or application of EIR practices. Knowledge of any potential benefits can only really be obtained through application of EIR activities, within existing protocols at a management level. For example, transport efficiencies can save costs and also reduce carbon footprints, but improving transport efficiencies begins as a designer level. Where management simply do not understand the value of transport efficiency and the techniques involved to attain it, little importance is placed on design specifications for material reduction and packaging improvements.

- Existing documentation makes it difficult to understand what the business benefits are to sustainability. This is simply because of the length and detail of the regulations makes comprehending them complicated and cumbersome to find any real value.

- Improved compliance would reduce fines and free up time spent working with the regulators, which could be better invested into the running of the business. Brand and USP could be enhanced by the promotion of more sustainable practices, allowing the organisation to segment itself against other less sustainable companies in the same sector, to provide differentiation.

4.6 Refinement of 20 Questions for the Industrial Questionnaire

Shown below in figure 14, the supply chain process map was used to provide context on how emerging issues were currently related to the over subject area. Where the affinity diagram holds value in grouping data into categories, the process map now enables these collective issues to be placed into context within a known system of operation.

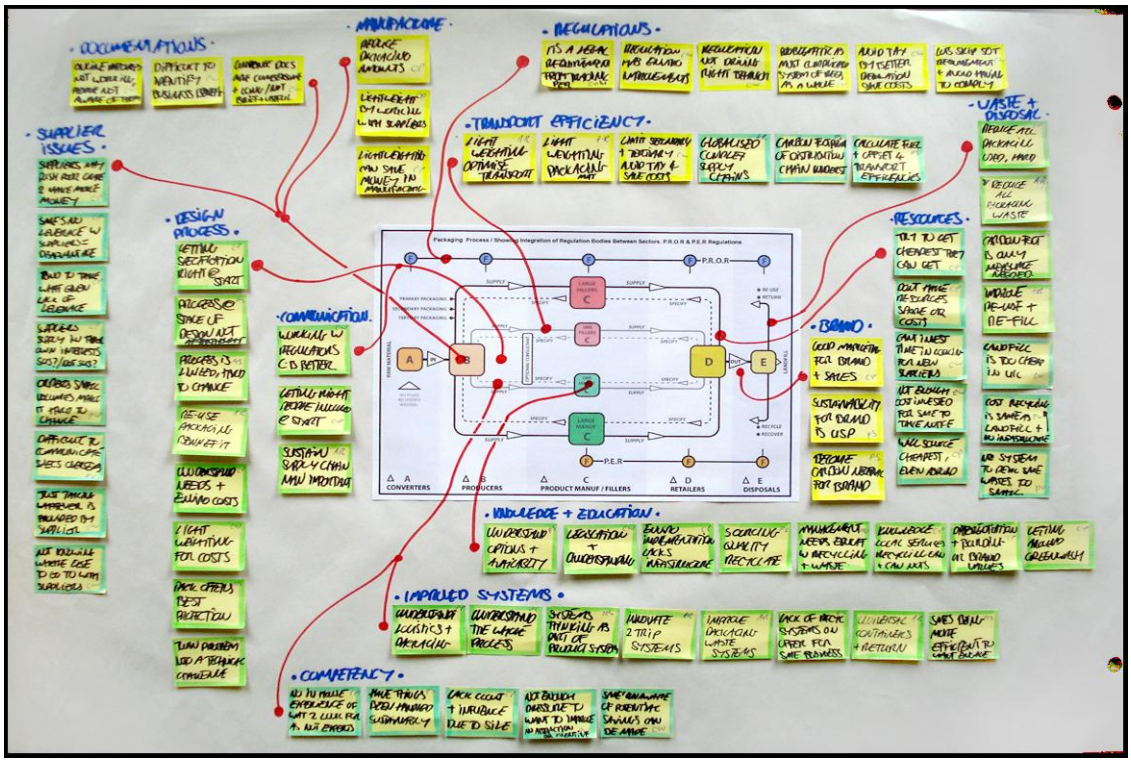


Figure 14: Showing points highlighted throughout the research merged with the process map, indicating where issues cluster in relation to specific operations.

The map demonstrates the ranges of issues which are related to each area, for example: eight factors for improvement with 'knowledge and education', at an SME level. Working in this manner enables the user to build discussion around exact points of process and highlight key topics which are emerging within the research. As the research project develops, these topics can be edited, removed or built on, at the convenience of new information and data becoming apparent to the user.

This method provided a practical engagement with the data, enabling others to discuss the emerging mapping process, SME supply chain operation and problem areas within. The next phase was to use a combination of the affinity diagram shown in figure 15 and the process map shown in figure 14, to filter the areas of most importance down to 20 questions.

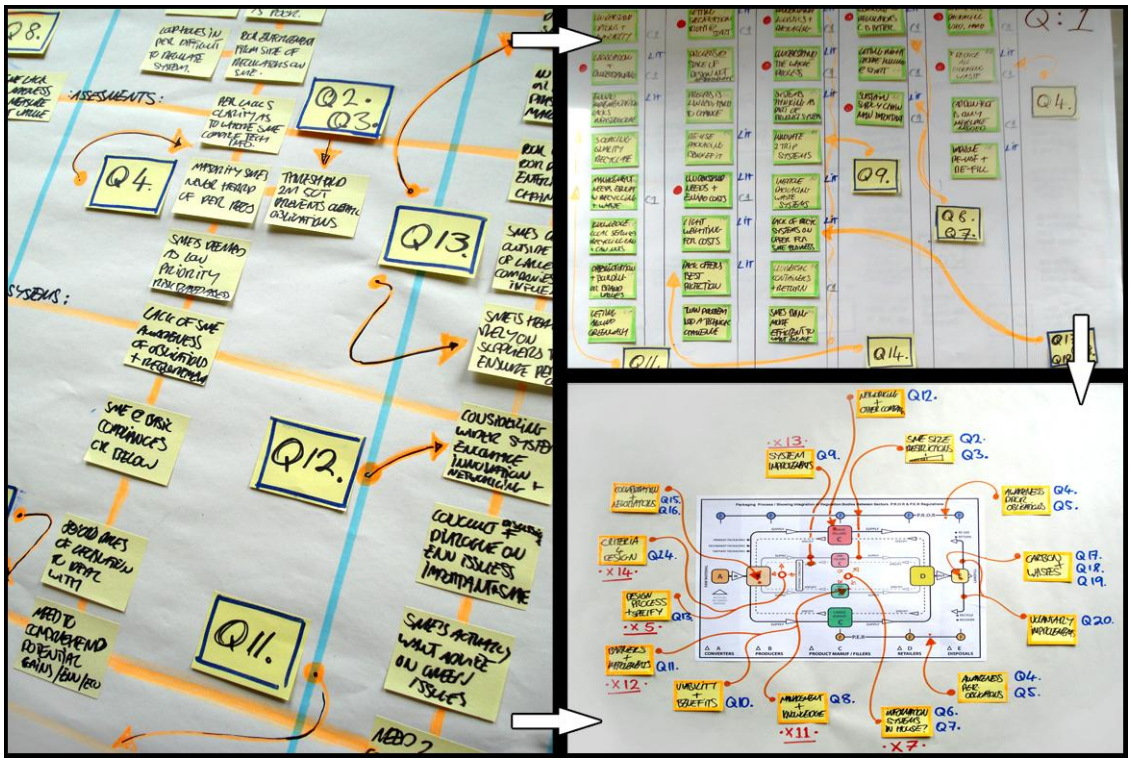


Figure 15: Showing a combination between the affinity diagram approach and the process map, to highlight where key areas are refined into an eventual 20 questions.

The overall purpose of the industrial questionnaire would be to keep the topics board in nature, to capture as much relevant information from the SME industrial sector as possible through the 20 questions.

4.7 SME Industrial Questionnaire

It was difficult to refine the industrial questionnaire to anything less than 20 questions which could cover the entirety of the concerns which had been identified. It was decided that each of the 20 questions would cover a specific area of the process map, shown in figure 16. Each of the 20 questions addresses a range of activities of which SME companies engage with during packaging specification and EIR.

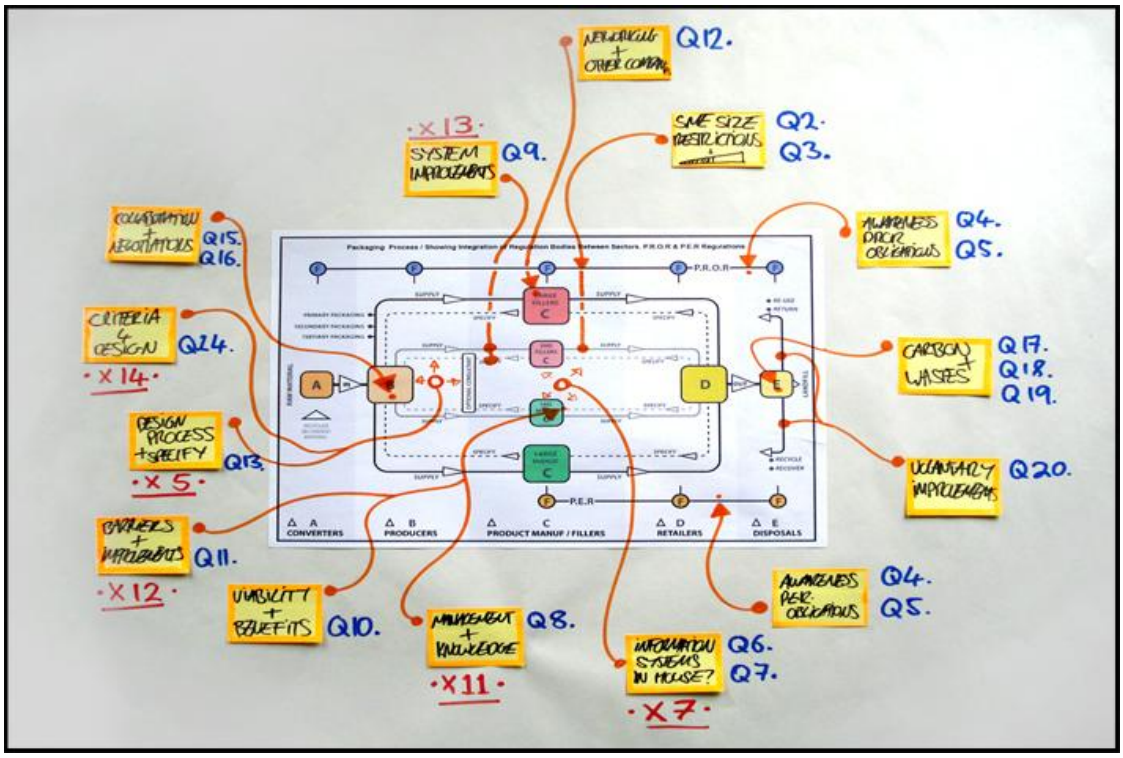
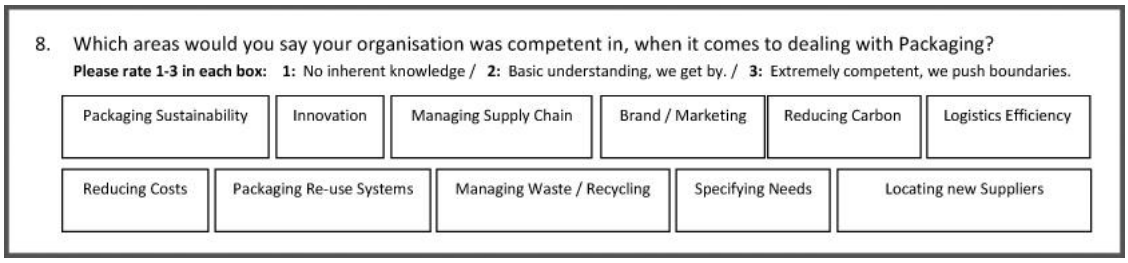


Figure 16: Showing where each set of questions, represents a area of concern identified through Delphi correspondence and mapping techniques.

Keeping the questioning broad was to identify new clusters of issues on evaluation through further process mapping activities.

Each question contained multiple choice responses, an example of this can be seen in figure 17. The overall goal of question 8 is to address internal competency at a management level, but in detail addresses a wide spectrum of tasks required by those responsible at this point of the process. Therefore, most questions followed this format as a micro questionnaire, covering a range of factors in multiple choice relative to a specific location identified within the mapping.


8. Which areas would you say your organisation was competent in, when it comes to dealing with Packaging?
Please rate 1-3 in each box: **1:** No inherent knowledge / **2:** Basic understanding, we get by. / **3:** Extremely competent, we push boundaries.

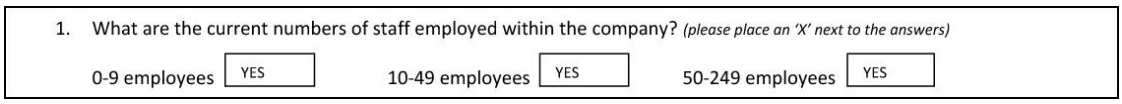
Packaging Sustainability	Innovation	Managing Supply Chain	Brand / Marketing	Reducing Carbon	Logistics Efficiency

Reducing Costs	Packaging Re-use Systems	Managing Waste / Recycling	Specifying Needs	Locating new Suppliers

Figure 17: Question 8, containing numerous points relating to the specific area under enquiry, to obtain maximum value from an individual query.

Draft industrial questionnaires were sent out to each of the industrial professionals on the Delphi panel to review the clarity and relevance of the questions being asked, (see appendix 1.7). Using the expert panels recommendations, helped to refine the terminology and that the questionnaire structure was logical for SMEs to engage.

The final industrial survey areas of questioning are as follows:


1. What are the current numbers of staff employed within the company? *(please place an 'X' next to the answers)*

0-9 employees YES 10-49 employees YES 50-249 employees YES

1. **Segmentation in employee size;** so that the research can compare data with the size of the SME correspondent against the capacity for EIR. This also treads new ground where literature groups SMEs together, but 249 employees will undoubtedly cope differently to those with just 50 or 10 employees.

2. Is the company's gross annual turnover £2 Million or more? *(please place an 'X' next to the answers)* YES | NO

2. **Stating the company's gross annual turnover;** this will go half the distance to deciphering if the SME correspondent meets the basic requirements to be regulated under law to deal with packaging waste on their premises.

3. Businesses that use 50 Tonnes or more of Packaging per year are covered by Regulations, Do you know how much Packaging you use by weight, is it over 50 Tonnes? *(please mark 'X')* YES | NO | DONT KNOW

3. **Tonnage in packaging turned over during the year;** to disclose the level of basic requirement within packaging waste regulations and their obligations.

4. Of the following, which have you heard of? *(please place an 'X' in the appropriate box)*
Duty of Care ☐ Producer Responsibility (PROR) ☐ Packaging Essential Requirements (PER) ☐

4. **Types of packaging regulation;** to question the knowledge and awareness of SMEs environmental practice, leading on from question 3.

5. Which of the following apply to you? *(please place an 'X' next to the answers)*
Duty of Care ☐ Producer Responsibility (PROR) ☐ Packaging Essential Requirements (PER) ☐

5. **Types of packaging regulation;** to question whether regulations are being applied in practice, even though the terminologies may be understood and they may essentially meet the criteria.

6. In terms of managing or enquiring within environmental obligations, what 'external' resources are used to inform or update your knowledge base? *(please briefly specify by placing an 'X' under the name)* **Please leave BLANK if none.**

1: Fed Small Business	**2:** Net-Reg's	**3:** Local Auth	**4:** Wrap /Envirowise	**5:** Business-Link	**6:** Trade Association	**7:** Consultants

If 'Other', please specify:

6. **Knowledge of external resources;** to understand which resource bases SMEs are currently using to educate themselves and reach out to others within existing supply chain networks.

7. As a consequence, if using these resources, how effective, beneficial have these been in improving your credentials / knowledge base? **Please rate 1-4 under the name:** **1:** Not effective, no Benefit / **2:** Limited benefit / **3:** Some help / **4:** Very Useful

1: Fed Small Business	**2:** Net-Reg's	**3:** Local Auth	**4:** Wrap /Envirowise	**5:** Business-Link	**6:** Trade Association	**7:** Consultants

If 'Other', please rate 1-5:

7. **Rating of external resources;** to test the worth of services provided to the SME community, if awareness or engagement with them is encountered.

8. Which areas would you say your organisation was competent in, when it comes to dealing with Packaging?
Please rate 1-3 in each box: **1:** No inherent knowledge / **2:** Basic understanding, we get by. / **3:** Extremely Competent, we push boundaries.

Packaging Sustainability	Innovation	Managing Supply Chain	Brand / Marketing	Reducing Carbon	Logistics Efficiency

Reducing Costs	Packaging Re-use Systems	Managing Waste / Recycling	Specifying Needs	Locating new Suppliers

8. **Internal competency;** to dig deep and find out whereabouts SMEs are proficient and where they currently struggle with managing packaging specific activities at management level. Understanding where improvements need to be made at the design and decision making stage of packaging development.

9. What would be the main factors that would 'encourage' you to take on board / consider new procedures to reduce potential environmental impacts? **Please rate 1-2 in each box:** **1:** No, not a priority / **2:** Yes, this would be influential to us.

Reduced Costs	Enhanced Brand	Competetiveness	Enviro Concern	Increased Knowledge	Funding	Avoid Fines

Consumer Pressure	Supply Chain Pressure	Innovation	Reduced Carbon	Transport Efficiency	Differentiation

9. **Incentives;** to indicate a range of benefits to see if SMEs show any interest in improving their current levels of engagement. Responses here indicate where the final process mapping would need to encourage a change in behaviour.

10. In addition to any potential obligations towards Regulation, are you currently aware of any Business advantages and benefits for investing resources in moving; 'beyond compliance' with Packaging design?

(please place an 'X' in the appropriate box)

YES	NO	DONT KNOW

10. **Business benefits;** to question the awareness of any real tangible incentive to engage in EIR activity.

11. What would be the main 'barriers' for you to take on board new procedures to reduce environmental impacts?

Please rate 1-2 in each box: **1:** No difficulty exists here / **2:** This would be a major Factor for us.

Lack of Time	Lack of Internal Resources	Lack of Knowledge	Return on Investment is Unclear	No Supply Chain Pressures

Lacking Skills	Not in Current Strategy	Stakeholders	Additional Costs	No Clear Benefits	No Interest	No Incentive

11. **Barriers;** to indicate a range of potential hurdles which may restrict SMEs from engaging with EIR activity, even if the prior incentive and behaviour is there to do so. This will help to refine the eventual process map for SMEs to navigate these problems at their own level.

12. Are you aware of what other companies within your industry are doing, in terms of implementing compliance and reducing environmental impacts?

YES: *(please briefly specify how):*	NO

12. **Awareness of others;** to understand how connected SMEs are with other organisations and to see if they are influenced by other practices which may set an example within the community. Networking is one of the first stages to entrepreneurship, when networking is lacking it is difficult to see outside of current practices, or break out of a silo mentality.

13. Where is the current specification and design for your packaging being carried out? *(please place an 'X' next to the answers)*

In House	Consultant / Consultancy	Off The Shelf / Catalogue	Packaging Supplier	Retailer / Customer

13. **Specifications location;** to understand exactly where design is taking place for the SME respondents. This will help to indicate exactly who is being responsible for the sharing of information within the current supply chains. Where knowledge is lacking and design responsibility is not in their hands, this may indicate poor communication between those they work with.

14. Which of the folowing criteria are important factors for you, during the specification of your current packaging?
Please rate 1-3 in each box: **1:** Not a priority / **2:** Interested but we lack the resource to implement / **3:** High Priority, part of current specification.

Material Reduction	Recycling	Cost	Logistics and Size	Material Choice	Innovation	Eventual Disposal

Fit For Purpose	Regulation Compliance	Sales	Reduced Carbon	Marketing	Convenience	None

14. **Specification criteria;** to provide a wide range of potential design considerations for the development of new product packaging.

15. Do you negotiate with your current suppliers to find the most optimum Packaging Specification to reduce potential Carbon Footprints? **Please rate 1-4 in the box:** **1:** Not at All / **2:** We don't know how / **3**: Rarely / **4:** Very Much So

15. **Negotiation;** to understand the levels of communication which are happening within existing supply chains between the SME product producer's and the importers and suppliers of packaging; in terms of optimising and resource efficiencies.

16. Do you engage in discussions with suppliers 'and' customers in relation to fulfilling potential obligations or reducing environmental impacts? **Please rate 1-3 in the box:** **1:** Not at All / **2:** Only when prompted / **3:** Very Much So

16. **Discussion;** to understand the levels of communication which currently orientate around regulations and obligations towards environmental responsibility; from both the side of the SME and also the packaging supplier.

17. Are there any processes within your organisation, which monitor the Carbon footprint of your Packaging within the current supply chains, to measure potential environmental impact? *(please mark 'X')* YES NO

17. **Carbon footprint;** to see what systems are being implemented in-house to manage the overall carbon content contributed throughout the supply chain on behalf of the SME. As environmental impact is now measured in carbon, it would be important for companies to be aware of the individual contributions.

18. Are there any systems in place which your company use to manage the recycling of Packaging Waste produced?

YES: *(please briefly specify):*
NO: *(please briefly specify why not):*

18. **Packaging waste;** to understand if there are any systems in place which manage the SMEs obligations towards packaging waste and recycling, through both regulation systems and also the design and disposal of packaging.

19. Are any toolkits or frameworks used within your organisation, to assist in implementing sustainability practices to reduce impacts or deal with regulatory Obligations?

YES: *(please briefly specify):*	
Advantages:	Disadvantages:

19. **Toolkits;** to see exactly what type of toolkits are currently being used by SMEs to manage their environmental obligations and responsibilities.

20. Would you happily engage in additional activity 'beyond' your legal compliance in Packaging, if it gave you an additional Business or Marketing advantage, which differentiated you against your competition?

(please mark 'X') YES NO

Thank You for your time.

20. **Differentiation;** to see if SMEs have any incentive to engage in further activity which may differentiate their organisation against the direct market competitors. Does the proposal of improved environmental status mean anything to SMEs to engage in activity outside of the current practices?

4.7.1 Packaging Supplier Industrial Questionnaire Data

It was considered that a reflective questionnaire should be additionally presented to the packaging producers, in parallel with SMEs (see appendix 1.8).

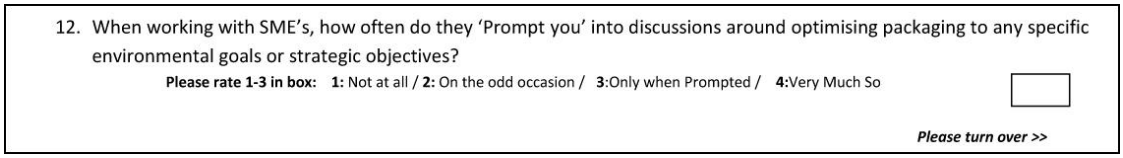


Figure 18: An example of the supplier industrial questionnaire with the focus reversed onto the SME's ability to discuss and negotiate.

The industrial questionnaire to be sent out to the packaging producers would involve the same 20 question approach with the same questions, but would focus on the supplier's perspective of SME levels of engagement during packaging specifications, as shown in figure 18.

The aim of the revised questionnaire was to understand the behaviour and attitudes of packaging suppliers when it comes to working with small and medium manufacturing companies. Research had previously indicated that SME companies tend to be at the mercy of their suppliers and lack the ability to ask informative questions. It raises the point that it may be that suppliers who are simply not engaging enough with SMEs.

If it could be concluded where any breakdowns in communication are occurring, process maps developed for the SME community could be better tailored to signpost towards areas of discussion and negotiation. Channels of communication could potentially open up between both parties to tackle any current flaws in best practice. This point was proposed for supplier input, as shown in figure 19.

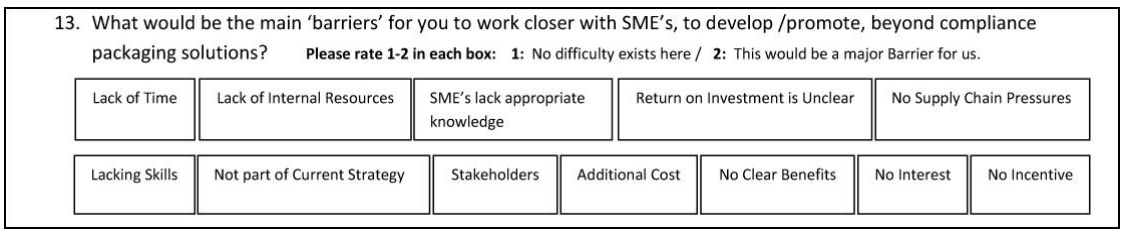


Figure 19: Looking to define the major issues which packaging suppliers face when working with organisations with less knowledge and ability.

4.8 Summary

This phase of the research investigation used a combination of affinity diagrams and process mapping, to group and highlight key areas which emerged from the literature review and subsequent panel conversations. External panels were used to obtain clarity on current issues which were identified within the literature review, to expand the level of knowledge required for informing the industrial questionnaire.

The next chapter focuses primarily upon the wide range of data from the industrial questionnaire which was returned from the SME sector. Focus is then drawn to the subsequent methods which were used to analyse the data, to extract where common EIR issues occur within all SME size group classifications.

5: INDUSTRIAL SURVEY AND POST ANALYSIS

5.1 Introduction

The previous chapter focused on the development of criteria for the industrial questionnaire which were identified through a process of exploration and refinement of data, provided from the literature review and external panel discussions. In order to synthesise points raised into categories and subcategories, affinity diagrams and process maps were used to add visual structure and definition. This was to enable a visual understanding of the research area to be developed and to identify areas of concern.

This chapter discusses the process which was undertaken with the further refinement of the process mapping technique for the simplification of complex environmental data for SME businesses. This will include the problems encountered when dealing with the industrial questionnaire returned by the SME community, and the restrictions encountered when trying to simplify the data by conventional data analysis software.

Original difficulty experienced with handling the data, originated as a consequence of submitting a contextually broad questionnaire, to the diverse SME product producing industry. The broadness in the approach to the industrial questionnaire, ultimately aimed to cover many topical issues which were defined through previous research activities. This was to enable further focus to identify which areas would become essential criteria, for a final process mapping system to be tested with SME product producers.

This chapter will therefore discuss questionnaire analysis, and how the process mapping technique was implemented and refined to enable the identification of the final criteria, for a relevant and effective SME process map of EIR activities.

5.2 Initial Data Resources & Corporate Researcher.

As a structured approach to gathering potential contacts for the industrial questionnaire, the business section of Newcastle city library was used to access Corporate Researcher. Corporate Researcher is a database of business organisations within the UK which can be used to attain corporate reports for the purposes of research and data analysis.

This provided a search engine which could be refined, in this instance the following criteria was applied:

1. *Sector size in employee numbers 0-49 / 50-99 / 100-199 / 200-250:* This was to ensure that an even number of industrial questionnaires were sent out to each specific SME size category, so that responses were not biased to one organisational size and then generalised over all SMEs within the data analysis.

2. *Industry sector; Food & Drink / Product:* These two industrial sectors were chosen because of the similarity of packaging type which would be used to protect and transport their product. General products, especially in the food and drink sector would typically have a high level of packaging turnover, which essentially unless recycled, goes towards energy recovery or straight to landfill.

3. *Annual turnover:* The annual turnover criteria would be one of the most important factors, considering that those companies with a turn over less than £2 million per annum are not legally obliged by the packaging waste regulations.

The time taken to collect and categorise all the potential SME contacts was lengthy in practice, but essential for consistency. Corporate researcher enables the user to download company reports as PDFs to be saved to external disks for future reference. Downloadable PDFs contain all additional information specific to the organisation

such as named managers / senior staff members and addresses for primary trading locations.

Having a much higher level of detailed information enabled package labelling and covering letters to be directly addressed towards persons of managerial position. This was important to ensure that potential respondents filling out the industrial questionnaire were in a position to comment on company operations. This selection process was additionally repeated when locating packaging supplier contacts for the packaging supplier questionnaire.

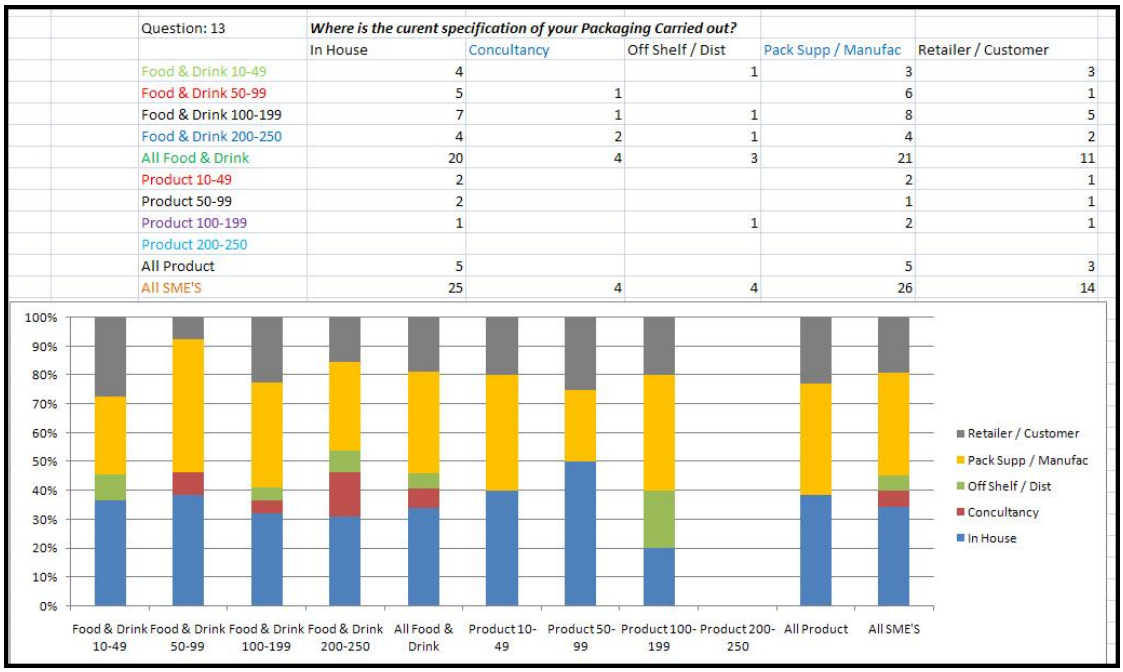
Each industrial questionnaire was packaged with a self-addressed envelope for returning to the University once completed and included the following;

- Pens.
- Covering note explaining our intention and what we can offer them in return. (see appendix 1.9)
- Business card.
- Industrial questionnaire.
- Self-addressed stamped envelope for returned post.

Responses to the industrial questionnaire were obtained over a two-month period and consisted of two sets of industrial questionnaires being sent out to 500 SME contacts. On reflection more responses were obtained from the SME sector by way of the second industrial questionnaire being sent out with a polite prompting letter. Yet again the prompting letter highlighted the benefits of the research and the potential for improvement as a result, stating that if organisations were interested the results would be made available to them upon request.

5.3 Data Analysis and Microsoft Excel.

PDF company credentials downloaded from Corporate Researcher were used to cross-check SME responses, to group each questionnaire into one of the four new SME size classifications. No SME responses were obtained within the 0 to 9 employee size, so 10 to 49 employees were chosen as the smallest SME size sector. Microsoft Excel was then used to numerically quantify and compare differing sets of SME size data next to one another and to make full use of Excel graphical applications to visualise the results.



Question: 13	*Where is the curent specification of your Packaging Carried out?*				
	In House	Concultancy	Off Shelf / Dist	Pack Supp / Manufac	Retailer / Customer
Food & Drink 10-49	4		1	3	3
Food & Drink 50-99	5	1		6	1
Food & Drink 100-199	7	1	1	8	5
Food & Drink 200-250	4	2	1	4	2
All Food & Drink	20	4	3	21	11
Product 10-49	2			2	1
Product 50-99	2			1	1
Product 100-199	1		1	2	1
Product 200-250					
All Product	5			5	3
All SME'S	25	4	4	26	14

Figure 20: Excel data sheet output, showing numerical data gained from the industrial questionnaire at the top, and graphical output for representation.

Excel is useful in this context in that it enables the user to gain a general quantification and then output this data to a series of bar graphs or pie charts for visual analysis. This can prove helpful when there is one set of data to be entered which needs to be represented in terms of quantity. However, this becomes somewhat more complex when there are multiple sets of data which must be entered alongside one another. As can be seen from the image in figure 20, numerical data from the industrial

questionnaire in relation to question 13, has been placed in SME size order from smallest to largest, including both food and drink and product producing SMEs.

Multiple-choice answers provided within question 13 have been colour-coded to show their weighting within each of the SME size category bar graphs. The key for these colours in relation to the multiple-choice responses are located to the right hand side of the bar graph image. While this method of using Excel does provide some visual indication to the data provided, the overall meaning of the data is still unclear and difficult to place into context. For those who need to place the data into context against an existing process to enable discussion or compare one question set against another, visually this opportunity is limited.

5.3.1 Limitations of Microsoft Excel with Multiple Data Sets.

A major issue with using Excel is that data entry is time-consuming and lengthy where inputs are numerous and detailed. A significant amount of time and resources were invested in building the Excel graphs. Benefit was limited due to the lack of visual unity between each graph for each question, when attempting to gain a holistic industry perspective. Some of the reasons that Excel was limiting in terms of representing complex data were as follows:

1. Excel works well when there is a clear initial indication of what is to be obtained and what to look for. In this instance it was unknown what to expect from the analysis, with the expectation upon Excel to highlight significant points within the data and draw clarity. In reality, there was no customised way to identify any emerging themes between different questions, as Excel is restrained to using simple graph layouts, which work independently.

2. Where some individual questions were simple straight yes / no answers, other questions contained a range of factors to consider, of which each factor required a multiple choice response. The graphical results from excel work fine if the intention is to study a range of factors, but usage becomes visually confusing when considering a range of factors with multiple choice responses.

SME SIZE	QUESTION:	FOOD & DRINK CATAGORY: 36 . 36	
	Question: 8	*Main barriers for you to reduce Enviro Impacts?*	
ALL SME		1: No Difficulty exists here	2: Major Factor for us
	Lack of Time	11	26
	Lack of Resources	11	26
	Lack of Knowledge	17	19
	Return is Unclear	9	28
	No Supply C Pressure	24	13
	Lacking Skills	23	14
	Not in Strategy	26	11
	Stakeholders	31	6
	Additional Costs	5	30
	No Clear Benefits	7	30
	No Interest	28	9
	No Incentive	22	15

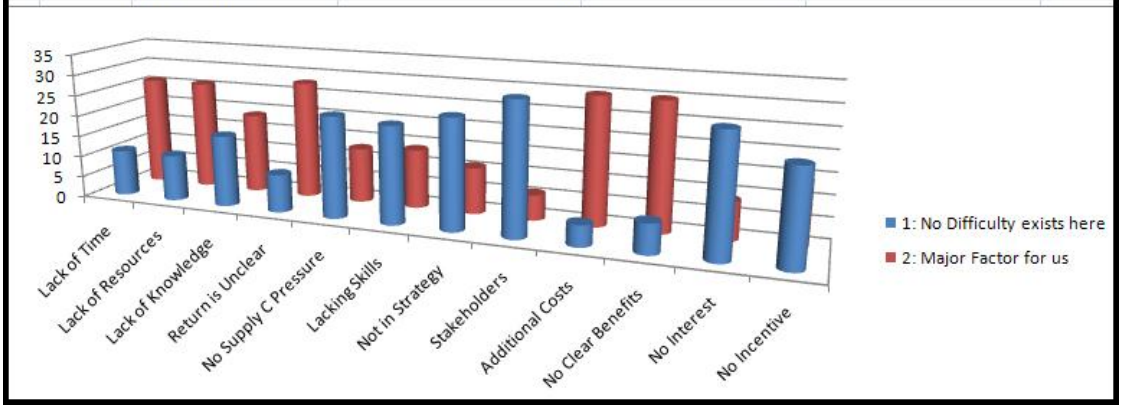


Figure 21: Simplified Excel data output, where all size categories have been grouped and responses separated into separate columns for visual clarity.

This was further complicated when trying to compare SME size classifications for the same question, and subsequently different areas of questioning from the survey. Using Excel graphs did not enable the research to view the results as a 'whole', for all responses over all SME size classifications.

The table in figure 21 demonstrates how Excel works well when the research subject is restricted to one group and explores only 2 variables within one question. In this format Excel does have its uses as it can be clearly seen that certain categories

contained within question eight, have a much higher weighting than others; such as the importance of additional costs, and no clear benefits to EIR highlighted in red. Therefore, striking the right balance between the required visual clarity in Excel and the range of factors to be analysed is essential for user engagement and interpretation.

Through the difficulties faced with Excel, further considerations were brought to light. Hidden within the data could be potential trends emerging between responses. Answers which may be given to one question may have a relationship with the response towards another. For example, SMEs which responded with a poor level of knowledge towards packaging regulations may also have indicated poor levels of negotiation with suppliers.

If this were the case, there could be some indication that the poor levels of negotiation with suppliers, may result in a lack of experience in learning the importance of government regulations through collaboration. In reverse, it could be suggested that an overall lack in understanding of the importance of government regulations, results in the lack of sustainability criteria being provided to the supplier through an inability to ask the right questions.

These types of indications within the data could only ever be recognised by the process of comparison across differing question sets. This would then enable further questioning to begin which tests the value of these hypotheses for any tangible evidence. This type of cross comparison is not easily obtainable through the use of Excel graphical representations.

5.4 Improved Process Mapping Requirements.

New objectives were drawn up to address the problems encountered within the initial data analysis from Microsoft Excel.

1. To find a process to more effectively enable the identification and highlighting of topical issues which emerge from the data.

2. To visually map data percentages in a visual language format.

The original process map which had been assistive in highlighting criteria for the industrial questionnaire in Chapter 4 was brought forwards for a third generation of refinement. Using the initial system as a template to analyse the industrial questionnaire data was a logical choice, considering that initial criteria for the questionnaire had primarily originated from its use. As the overall packaging system boundaries had previously been defined in terms of supply chain processes and where SMEs relate to these in context, the appliance of this knowledge could be brought forward as a new framework for data entry.

A new system map was drawn up as can be seen in figure 22 using the original supply chain narrative, while expanding each SME question at their respective point in supply chain process, as originally defined in figure 11. Therefore, figure 22 is a more detailed version of figure 11, which now enables the re-entry of industrial questionnaire data as an overall snapshot diagrammatic.

Figure 23 shows an example of all SME data for all 20 questions, entered into one visual template to represent the responses from the 10-49 sized UK manufacturing SME's.

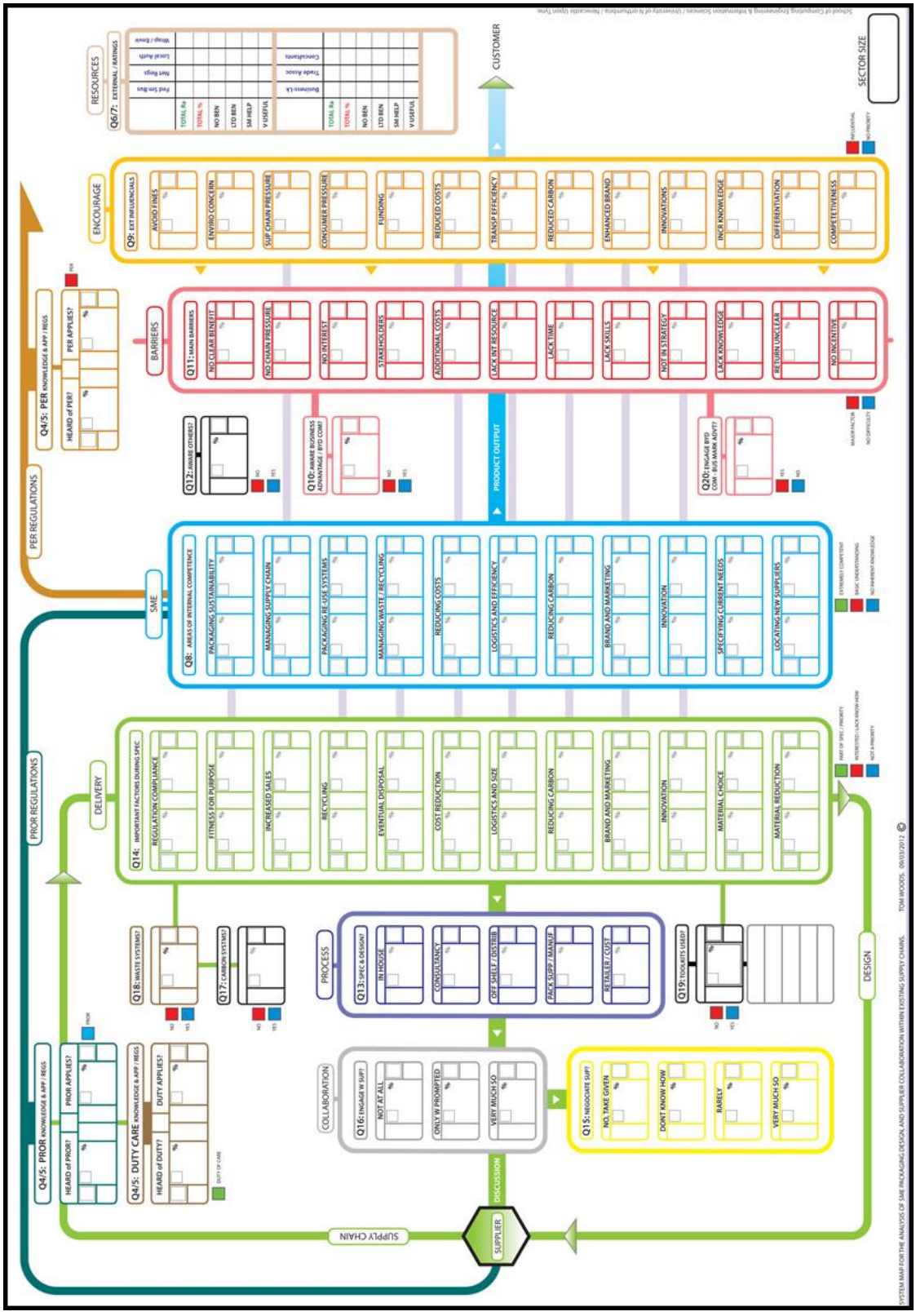


Figure 22: The new iteration of the SME process mapping tool, using the existing process map defined in figure 11 with the integration of the industrial questionnaire.

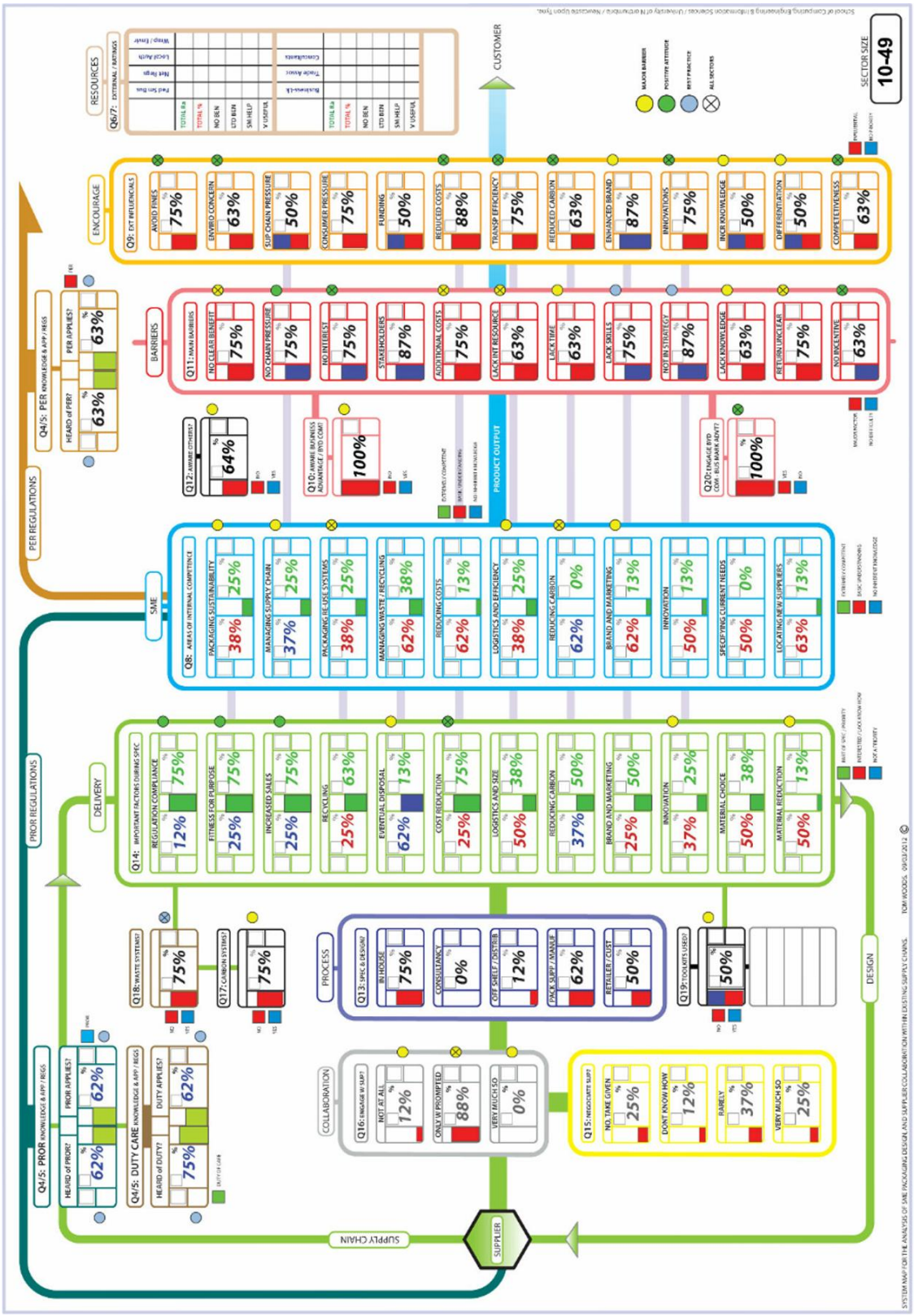


Figure 23: The new iteration of the SME process mapping tool, with 10-49 industrial questionnaire data embedded within the map to gain an overview of industry issues.

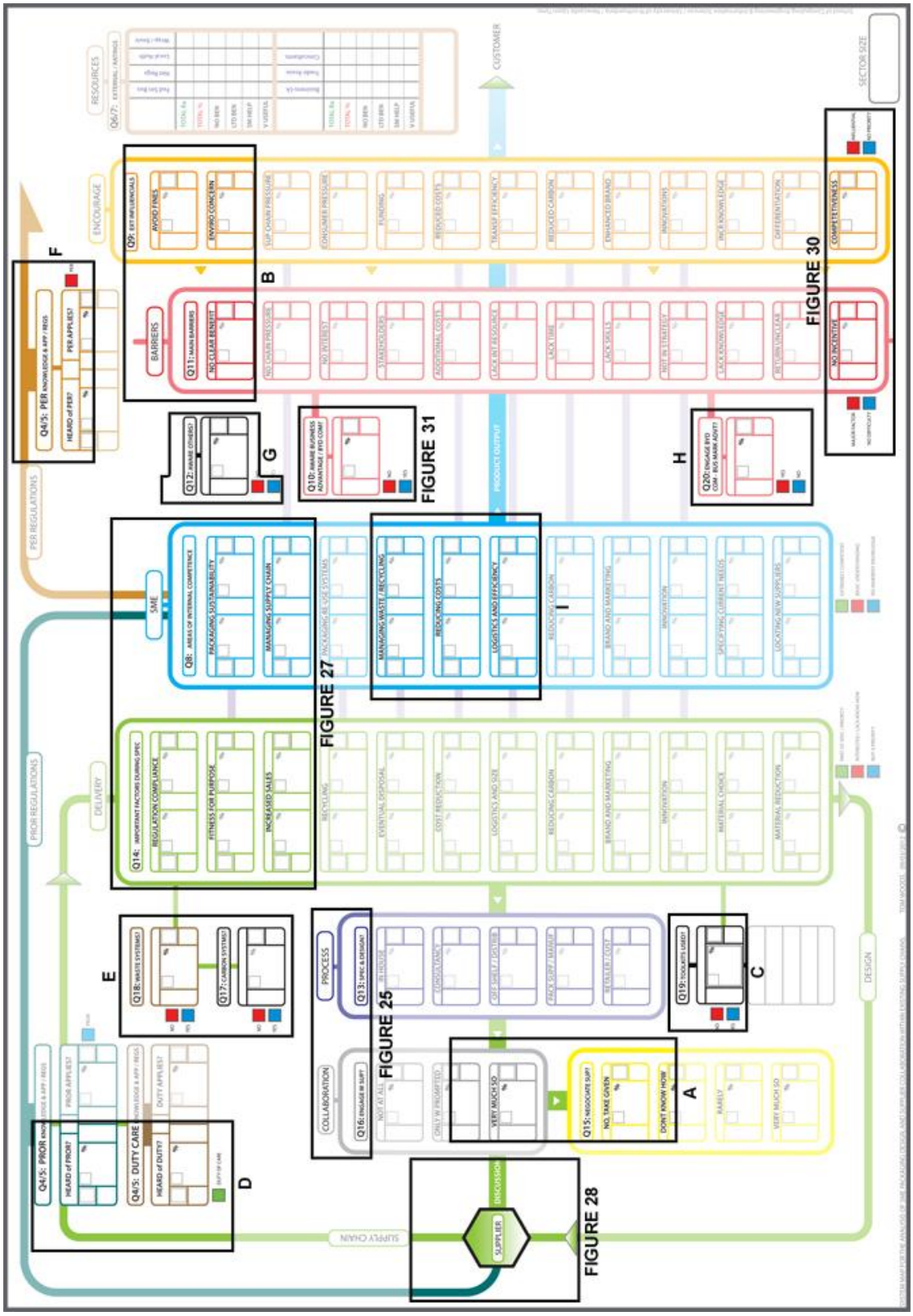


Figure 24: The new iteration of the SME process mapping tool, with highlighted areas in relation to points to be discussed within the remainder of the current chapter.

5.4.1 Improved Process Mapping Procedures

In figure 22 the layout of the new process map design shows a number of separate coloured boxes, spread out across the width of the page from left to right, connected by various coloured lines. Each of these coloured boxes contains information which is directly applicable to, and covers all points contained within, a question from the industrial questionnaire. Therefore, each coloured box is numbered in relation to a question and represents the placing of that question within its supply chain context.

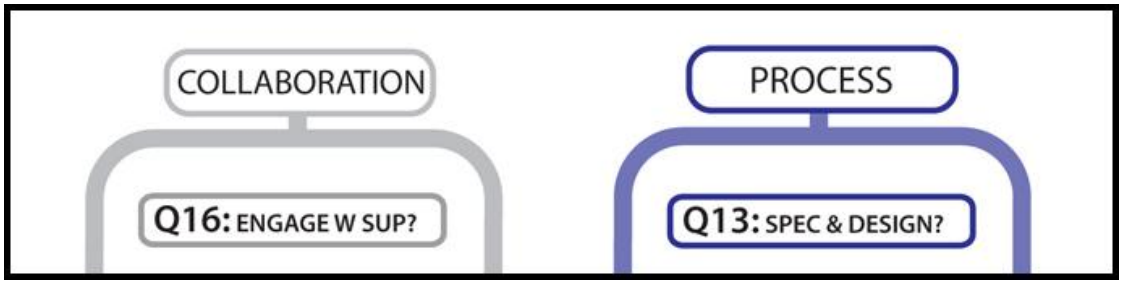


Figure 25: Showing the labelling of each of the coloured boxes contained within the new process map, each representing an area which is specific to the industrial questionnaire, sent out to the SME product producing community.

As can be seen in figure 25, and figure 22, question 16 and question 13 are shown with a colour, title, and a heading in relation to the overall context. Therefore, each number located inside each of the coloured boxes represents one of the questions from the industrial questionnaire. As the industrial questionnaire consisted of 20 questions, this therefore results in 20 separate boxes being placed within the map, assigned to their appropriate location. As previously mentioned within Chapter 4, each question within the industrial questionnaire sought to address a range of issues.

Question eight for example, shown in figure 26, covers a range of points specific to SME competence when dealing with sustainability at managerial level.

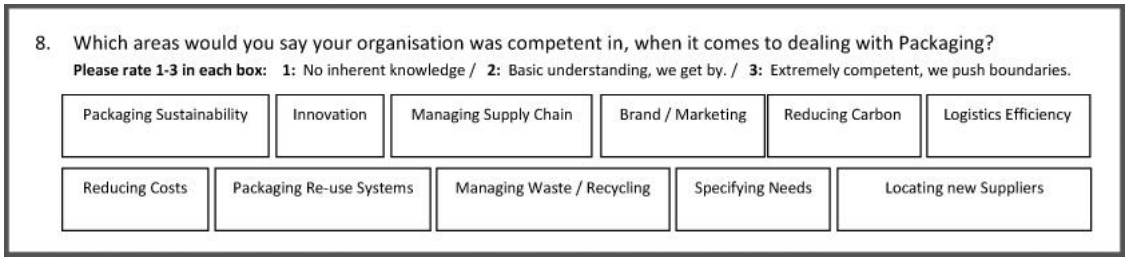


Figure 26: Showing the original layout of the industrial questionnaire for question eight, where numerous points have been raised in relation to a specific point in NPD.

For the new process mapping tool, each of these points from question eight were placed in vertical order from top to bottom within their own coloured box as seen in figure 27.

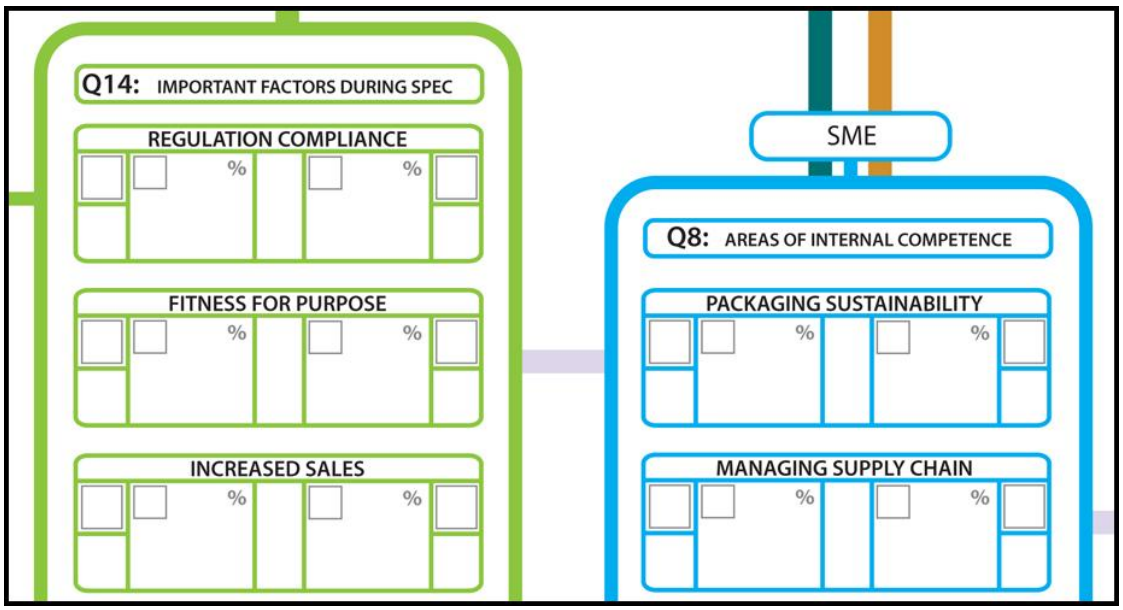


Figure 27: Showing how original data entry points used within the industrial questionnaire, have been adapted to fit within the new process mapping framework.

All other areas included within the industrial questionnaire have been adapted to fit this new format and placed accordingly within the map. For example, the original process map in figure 11 demonstrates the packaging supplier being placed upon the left-hand side of the diagram as shown in image A of figure 28. This is indicative of the supplier being at the start of the supply chain.

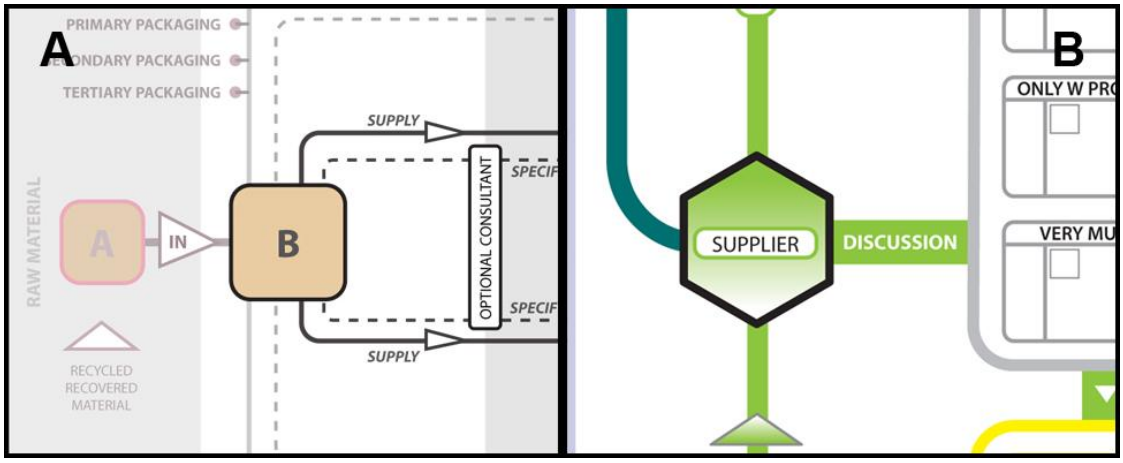


Figure 28: Showing that the points of reference assigned to the original process map in Chapter 4 have been used for the new process map developed within Chapter 5.

This is still the case as shown in image B of figure 28, and also shown in figure 24. As all product packaging originates from the packaging supplier in terms of manufacture, the packaging producers have been placed at the beginning of the mapping process.

This is the same for the SME organisation being placed at the centre of both mapping versions, with the exception of the new mapping version including space for question answers, shown in B of figure 29, and also shown in figure 24.

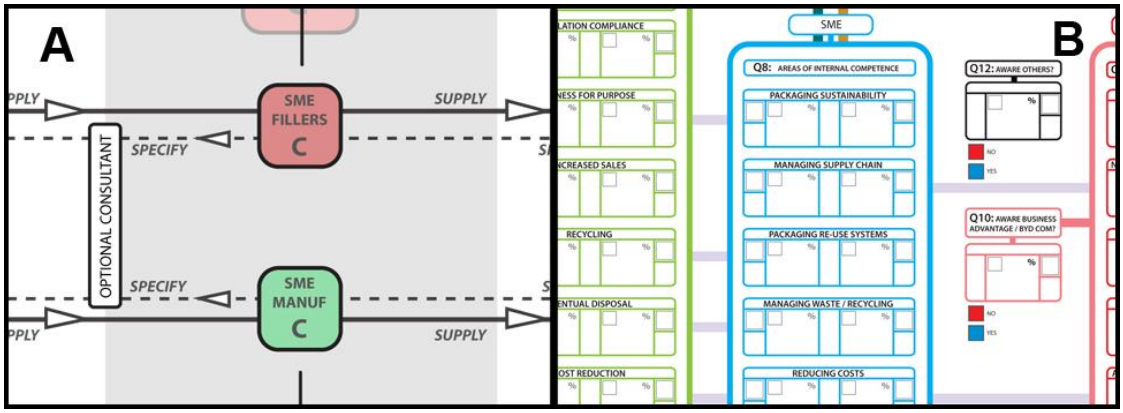


Figure 29: Showing the identical placing within both process maps for the location of SME product producers, within the systems of packaging supply chains.

The benefit of using an overall process map such as in figure 23, is it enables the user to gain a bird's eye view of the total problem space under consideration. Using a known system enables the user to make a visual and mental association, which places

data into context and can indicate relationships with adjacent data. Using a simple visual language such as colours assigned to each of the boxes, builds associations with the type of data contained and the colour used to represent it. This assists with the grouping of data into specific categories by cognitive recognition, rather than bullet point format on an A4 page. In theory, working with a process map which is tangible to users where data boxes could be added, removed or swapped around within the system, provides an opportunity for a more practical engagement with company specific data, rather than simple paper-based report formats.

5.4.2 Data Boxes for Question Points & Graphical Tagging Analysis.

To provide further visual engagement with individual sets of data, additions were made in the form of coloured symbols to assign particular coding where required. Data boxes were designed and placed inside each of the question boxes to handle responses for each of the points in relation to any given question. An example of these data boxes without any embedded data can be seen in figure 27, and also with images "A to I" in figure 24, spread throughout the process map to represent each question.

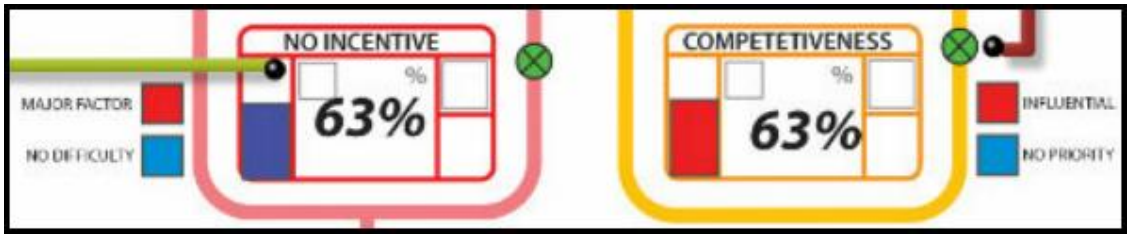


Figure 30: Showing the overall value in terms of percentage, for two separate points asked within two separate questions, and a colour bar adjacent to the left-hand side of the percentage, to indicate the volume of responses visually for quick reference.

The purpose of the data box is to place a percentage into the centre, to enable quick comprehension of a result against other results within the map; as can be seen in figure

30 and figure 24. The data box provides both numerical and visual communication of data entry.

Shown in figure 31, results inside the data box would be displayed as:

1. Overall responses converted into percentages and placed within the centre. Significance within the results was assigned where percentages were significantly high or low. As points of enquiry were based around sustainable best practices, negative results were defined where respondents showed a lack of competence, and / or awareness in the value of the enquiry.

2. A colour bar was used to visualise the percentage, shown within image B of figure 31. A partition of the bar would be filled with colour to a level which indicates the percentage of the answer. For example, if the response was 50% within the data box, then half of this partition would be filled. Colours used within the bar would be indicative of the response, for example: Blue for YES and red for NO. An example of this coding is in figure 31 image A.

3. Two small partitions located to the right hand side of the data box, contain information in relation to larger or smaller SME sector sizes. As the overall SME sector has been broken down into four smaller categories, comparing responses within each of the four was of importance to indicate varying levels of proficiency. Arrows were used here to indicate an increase or decrease in response against the preceding SME size classification. A numerical percentage is also provided for reference.

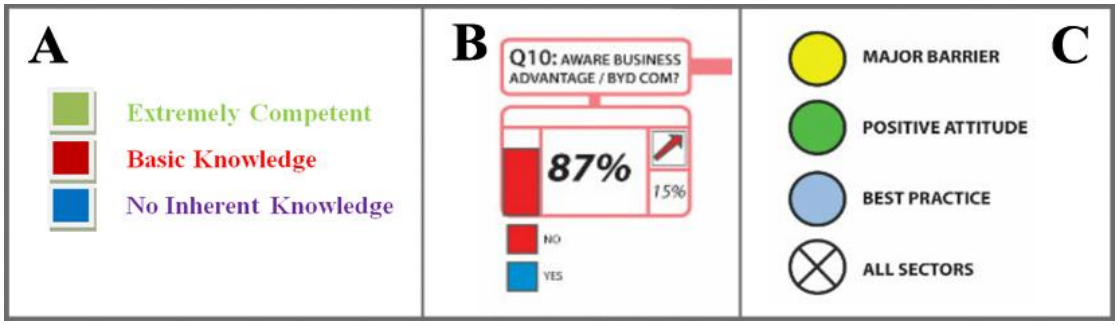


Figure 31: Showing the various visual coding which were included in this situation of the SME process map, to provide further ways to engage within the data contained.

On reflection, an error occurred when assigning the visual coding for this iteration of the process map. No consistency was initially maintained within the labelling of the coloured boxes in relation to the multiple-choice answers placed within the map. For example in within figure 31, image "A" demonstrates green as being a positive response, and blue as being a negative response. Not only was the visual language incorrect in the sense that most people associate red as negative, but in comparison to image "B", blue is used here as a positive result. This caused some complication when discussing the overall results with peers and team supervision. Those who were unfamiliar with this visual language had to review their understanding of it in order to interpret each of the questions.

Further visual icons were created which served to simplify and finalise the overall data visually, seen in image "C" of figure 31. These icons were:

A. *Barriers:* where there is a clear indication of poor proficiency and poor levels of engagement within the industrial questionnaire areas. Highlighting barriers indicated areas for development though further process mapping refinements.

B. *Best practice:* where there is a clear indication of proficiency and competence demonstrated within responses from the industrial questionnaire. Identifying areas which are positive enables the further questioning of why particular

sectors are competent compared to others, in relation to the particular topic in question.

C. *All sectors:* Because SMEs were separated into four different sized categories, an additional symbol was used to indicate where consistency across the four sizes was identified.

Another error was made when using the tagging principle to highlight responses within the map. An additional green symbol was implemented to indicate where SMEs demonstrated a *'positive attitude'* towards responses from the industrial questionnaire. In hindsight this served no purpose when informing the further development of future mapping processes or indicating areas to be considered for further review. This was mainly due to *positive* responses being contextually too similar to those marked as best *practices*. Subsequently responses to these were eventually grouped.

The tagging procedure can be seen in operation here in figure 32 and figure 23.

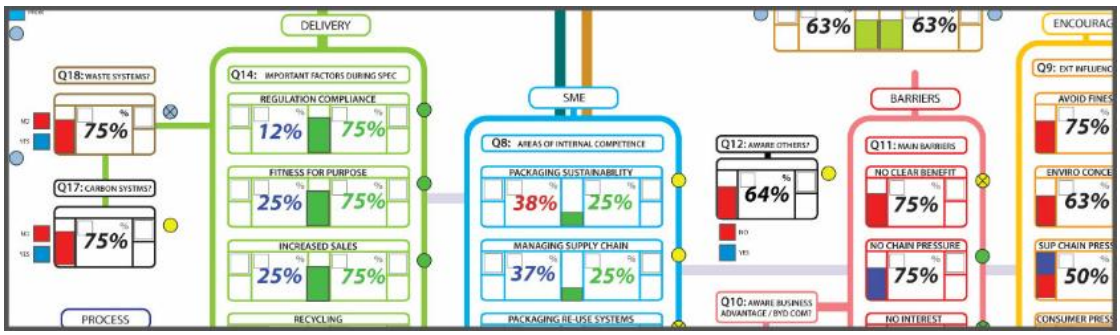


Figure 32: Showing where data tags, indicative of barriers and best practices are assigned within the overall mapping process to highlight areas for discussion.

At a glance, the data tags enable the user to quickly grasp an indication as to the assigned value at specific SME sector sizes. Color coding quickly enables the user to identify if the areas tagged are of an environmental concern, or an example of a best practice.

The overall aim of this mapping phase was to create a visual replication of industrial factors, sitting within a known system of operation. Essentially this provided an *'overall architecture'* for the current levels of SME competence, demonstrated at each of the defined system points of enquiry, for the SME sector sizes under question.

5.4.3 Data Threading and Potential Trend Identification.

It may be that multiple responses within the data potentially share the same underlying issue. The application of the visual approach was to connect data results with a specific threading technique, as seen in figure 33.

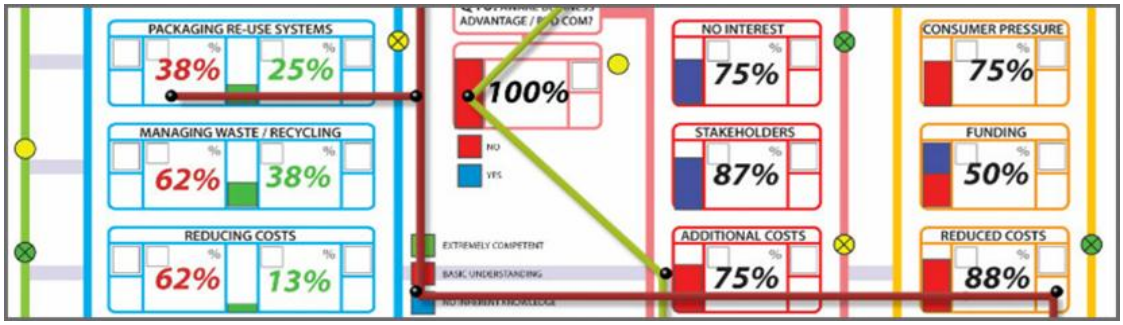


Figure 33: Showing the threading method where differing data responses may share potential underlying connections, for further review and consideration by the user.

Essentially the threading technique can be used to demonstrate where potential synthesis exists between different factors within the mapping process. **Red threads** were used to connect *'problem and solution'* factors within the map, and **green threads** were used to connect 'problem and consequence' factors within the map. Although, results can only be indicative for further consideration rather than definitive through actual evidence. However, this engagement can encourage the user to think more broadly about the relationships between organisational factors, and knock on effects of current practices.

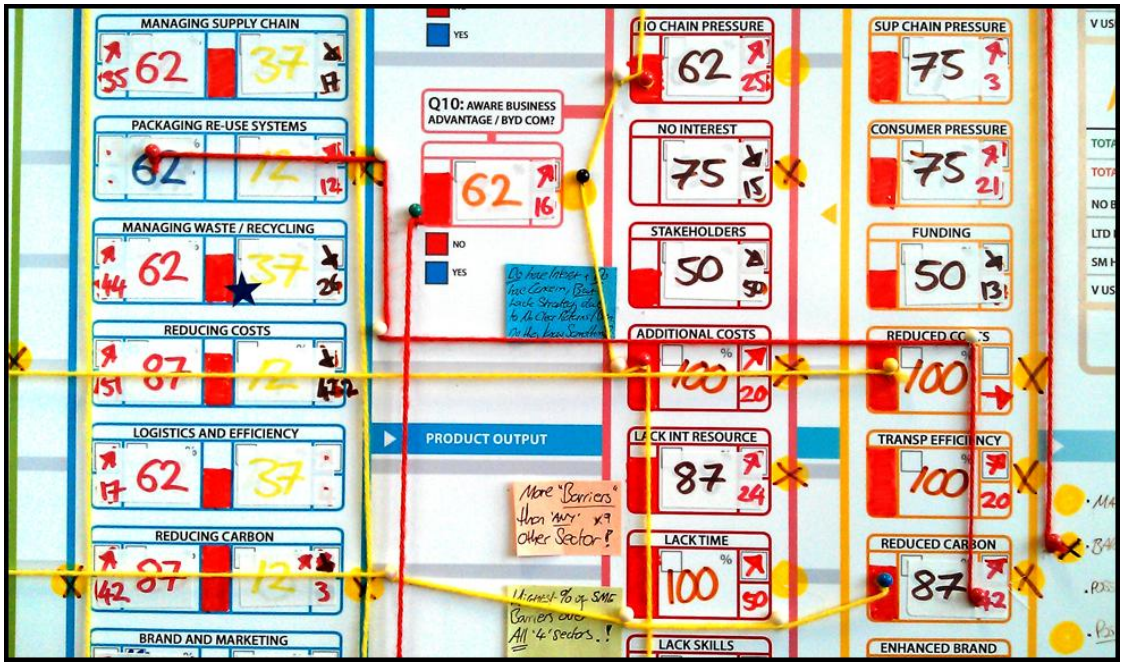


Figure 34: Showing the threading method in practice to indicate where desirables could be attained through adjusted practices.

Figure 34 shows where a **red thread** has been used to connect different question results within the map. In this instance, results indicated that 62% of this SME sector *'lacked knowledge'* with implementing 'packaging re-use systems' in the top left of figure 34. Additionally, *'reduced carbon footprints, transport efficiency and reduced costs'*, factor high percentages as *'incentives to improve'*, shown to the right hand side of figure 34. The **red thread** simply indicates that if *'packaging re-use systems'* were implemented, the highly rated incentives could be attained.

This approach simply makes it possible, to consider organisational factors on a wider scale, in contrast to dealing with each factor in isolation. The use of mapping can therefore be indicative of further avenues for consideration, as a prompting tool for EIR activities.

5.5 Industrial Survey Overall Results from all SME Sector Sizes.

Through the use of the process mapping technique it was possible to break the overall SME sector down into the four different categorical sizes, and observe differing trends within the data for each. Each SME sector size demonstrated its own characteristics in terms of how environmental practices were managed with varied attitudes towards best practice. The overall objective of the process mapping phase was to indicate where specific EIR concerns were most common amongst the range of SME product producers. These concerns were to be considered as essential criteria for inclusion within the final mapping process for SME EIR. The following information outlines a brief summary of the results for each SME sector size, including areas for improvement, and areas of best practice. A detailed description for each SME sector and an accompanying table of results can be seen within appendix 1.10.

5.5.1 SME Sector Size A, 10-49 Employees

Key Areas for Potential Improvement:

Packaging re-use systems / Reducing carbon footprints / Appliance of innovation / Lack of understanding towards packaging sustainability / Lack of appropriate knowledge for packaging specification / Lack of negotiation, collaboration with externals with regards to reducing environmental impacts / Lack of design for disposal / Lack of understanding towards material choice, reduction / No awareness of benefits beyond current compliances.

Key areas of good practice:

At best: Managing waste and recycling; Positivity towards change and improvements.

5.5.2 SME Sector Size B, 50-99 Employees

Key Areas for Potential Improvement:

Packaging re-use systems / Reducing carbon footprints / Little awareness of others companies and their practices / No awareness of benefits beyond compliance / Lack of negotiation, collaboration with externals with regards to reducing environmental impacts / Appliance of innovation / Lack of understanding towards packaging sustainability / Lack of understanding towards regulations for packaging design.

Key areas of good practice:

Managing waste, recycling / Locating new suppliers / reducing Costs / Managing supply chain / Placing a higher priority on the specification stage / Positivity towards change / Comprehension of regulations for waste / Implementation of internal waste systems.

5.5.3 SME Sector Size C, 100-199 Employees

Key areas for potential improvement:

Packaging re-use systems / Reducing carbon footprints / Appliance of innovation / Lack of understanding towards packaging sustainability / Lack of understanding towards regulations for packaging design.

Key areas of good practice:

Managing waste, recycling / Locating new suppliers / Reducing costs / Managing supply chain / Placing a higher priority on the specification stage / Negotiating with suppliers in relation to carbon reduction / Collaboration with suppliers and external parties for reducing environmental impacts/ Awareness of others / Awareness of

business advantages beyond compliances / Positivity towards change / Comprehension of regulations for waste / Implementation of internal waste systems / Tool kits.

5.5.4 SME Sector Size D, 200-250 Employees

Key Areas for Potential Improvement:

Packaging Re-Use Systems / Reducing Carbon footprints / Appliance of Innovation / Lack of rated knowledge towards packaging sustainability / Little awareness of others companies and their practices / Unaware of benefits to move beyond compliances / Lack of negotiation, collaboration with externals with regards to reducing environmental impacts. Most areas within 'Q.8' for competence, demonstrate a *Basic* level of knowledge throughout.

Key areas of good practice:

Positivity towards change / Comprehension of regulations for waste / Comprehension of regulations for packaging design / Implementation of internal waste systems.

5.6 Overall Data Results, Sector Trends and Areas of Opportunity

The most consistent response from all those who took part in the industrial questionnaire, was the upmost need to *reduce-costs*, as being the biggest influential factor for SMEs in product development. Alongside this, results indicated that SME companies were positive towards engaging with additional activities, beyond their legal compliance, if it was to provide them with a *business and marketing advantage* against their direct competition. Responses have been positive over all SMEs in relation to moving beyond current levels of sustainability, if actions can be made understandable with *clear benefits which are attainable*.

Over the four size divisions, potential barriers which respondents share revolve around the *lack of understanding* and poor education of *known-benefits* for any sustainable improvements. Any advancement to rectify this is also hindered by restrictive organisational capacities to take on or justify new approaches. These two main points can be seen unanimously for all SMEs, where a *lack of clear benefits* and *unclear returns* are rated highly as major barriers for SMEs. This is also supported by equally high ratings where respondents are unaware of any current *business advantages* to justify or seek out improvements. It appears that the incentive and interest to take on approaches towards contemporary sustainable development is there in hand, but the benefits for doing so are simply not clear enough. A consistent response from all SMEs appears to be the high levels of importance which have been placed on the potential of *reducing carbon footprints*, as an influential factor for encouraging new procedures. This is an area which packaging consultants voiced was a challenge for SMEs to manage their own carbon levels. Packaging consultants stated that everything is now measured in Carbon content, so this would be of a premium for SMEs who wish to be market as Carbon neutral company.

Within the area of *internal competence* of SMEs dealing with Carbon footprints, only a low level of priority was placed during specifications for packaging with suppliers. The external panel voiced that SMEs lack clout when dealing with their suppliers. Moreover, the reduction of carbon footprints may not only improve aspects for environmental gain, but considerably reduce costs. Reducing costs through better carbon management may also help to *reduce fines*, which also scored highly from SMEs, if attainable. *Transport efficiencies* also scored highly as an influential area for improvement. Less packaging through design would provide a reduction in weight and cubic efficiency, both reducing carbon content during manufacture and delivery.

Packaging re-use systems were rated the least applied of all practices across the board for SMEs, demonstrating the *lowest* ratings of competence, and the *highest* overall ratings for gaps in knowledge implementation. Previous collaboration with the European Environment Agency stated that re-use systems had become a passing phase with SMEs than they had been over previous years. Therefore, the re-education for the potential of re-use systems to improve transport efficiencies; reduce the use of resources; reduce overall costs; improve environmental profiles; and significantly reduce carbon content and land-fill, would appear to be largely influential to communicate to SMEs based on responses to these areas being of critical interest to them.

5.7 Summary

On reflection, this third iteration of developing a process map for SME EIR turned into a prototyping phase for data capturing and synthesis. What the overall process map did provide at this stage of the research was a highly detailed indication of the complex processes at work within the SME sector, and the factors of concern for EIR improvements. The next chapter will present each identified factor for improvement in EIR and discuss them in greater detail for inclusion within the final mapping design. Additionally, mapping improvements will be addressed through another loop of developmental refinement, in preparation for Delphi panel evaluation.

6: FINAL DESIGN FOR PROCESS MAPPING IMPACT REDUCTIVE PRODUCT DEVELOPMENTS

6.1 Introduction

The previous chapter focused primarily on the development of the industrial survey for the SME sector and the additional post analysis of data from the returned questionnaire. The areas contained within the industrial survey covered a range of sustainability criteria which had been defined through both a literature review and then subsequently working with an external panel of professionals. The external panel of professionals were chosen on the basis that they each represented an area of EIR activity which was initially identified within contemporary sustainability literature in regards to SMEs. Working with a balance of accessible data between both the literature review and subsequently the external panel, enabled the research to become reflective and reflexive in the development of instrumental key criteria for SME EIR requirements.

As a method of channelling and representing data which was progressively uncovered during the research, process mapping was implemented to provide a platform which could assign visual context to the data. This context was achieved where SME survey data was visually positioned within a known system of supply chain operation, to enable tangible interaction against a series of visual processes.

After reflection on the preceding research activity, this chapter will now address the subsequent and essential improvements required for a more effective process mapping technique. Additionally, this chapter will also incorporate the refined essential criteria for SME sustainability, which was previously defined through the industrial survey. The combination of the refinements in both of these areas will result in the fruition of a generic EIR framework, which contains value in relation to sustainable NPD and attention to detail in relation to user engagement.

6.2 Criteria for Mapping Development in NPD Structure and Flow

The previous process map in Chapter 5. essentially lacked both an order of operation from start to finish, and a synthesis with an existing process relative to the comprehension of an SME management structure. Objectively for the research, the previous process map served its purpose well in the sense that it provided an overall indication of industry concerns in relation to sustainability from a bird's eye perspective. This previous format was essential in order for the research to be able to capture an overall picture of industry processes. This overall snapshot enabled points of discussion to be raised in relation to where improvements can be targeted for SME sustainability concerns.

This approach proved invaluable in the context of moving the research forwards and defining key objectives, but for an SME, this format may provide no relevance at a management level seeking internal improvements. Therefore, to enable the process mapping procedure to become transferable for SME's, the first criteria of improvement required the basis of mapping operation to mirror existing NPD narrative which is comparative at an SME management level.

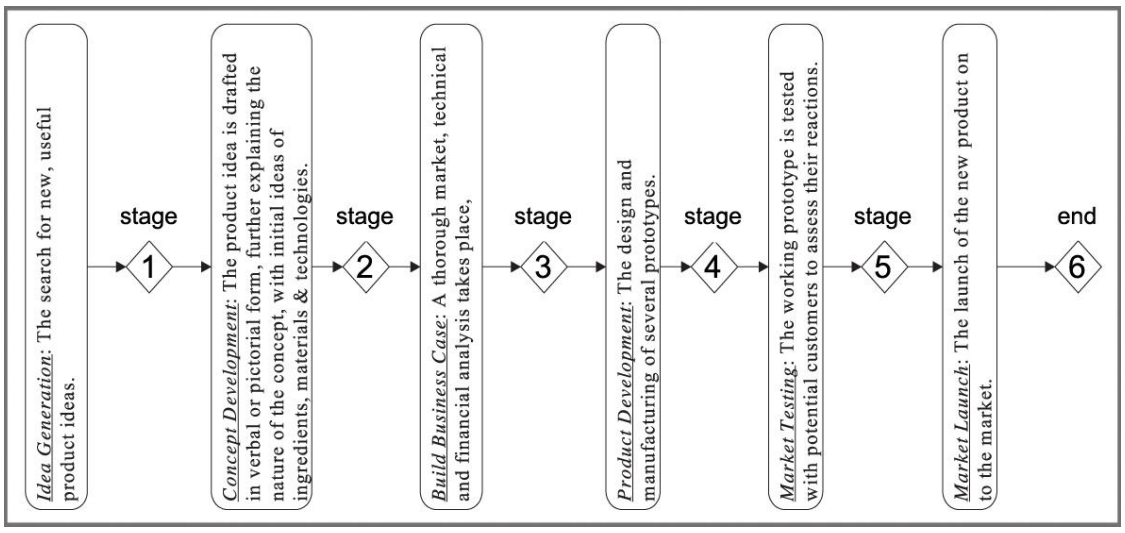


Figure 35: Adapted from Tzokas, et al, model of the Stage and Gate Process (2004).

For this reason, the Tzokas model of the Stage and Gate Process to new product development, Tzokas et al, (2004), p.620 was used as an original basis to begin transcending components from the industrial survey process map, into a more comprehensible and comparative SME management format.

As can be seen in figure 35, the NPD process which is discussed in detail within Chapter 2, effectively breaks down the operation of developing new products and services into a series of logical steps throughout project fruition. These steps allow for evaluations to be made, where project progress is continuously assessed against strategic objectives to safeguard against potential failures.

Although the image in figure 35 shows only a very general approach to each of the product development stages, it does illustrate how a system narrative with steps, can separate major operations into a number of basic components. This separation into a number of basic components exposes opportunity for the interpolation of various sustainability criteria, amongst others, to be assigned at their relative location within the overall wider NPD activity.

Merging current NPD narrative with a visual process mapping technique enables a synthesis and recognition for the SME user with the process mapping tool. This has provided a skeleton framework with which to develop process mapping requirements from the previous research activity, into a more comprehensible format as part of the iterative development process of the Delphi research method.

The results from this have provided criteria for essential improvements within the following areas:

1. *Timeline:* through using NPD as a basis for the process mapping tool, a narrative has been presented which incorporates a logical start and end point for user engagement, as can be seen in figure 35. Not only does this create boundaries with which to work in conjunction within process mapping tool, but it additionally enables the user to interact with the tool at any particular point of the process by way of association with existing product development narrative.

2. *Clarification:* as SME organisations demonstrate varying levels of proficiency within standardised NPD, it therefore requires that the process mapping tool be rooted in a generic approach to NPD which can resonate across a wider audience. In essence, creating a generic approach to NPD as a basis for the process mapping tool, will afford familiarity with those more experienced with NPD, and assist those who are not so proficient by filling in the gaps in knowledge.

3. *Synthesis:* using a generic NPD timeline can enable the integration of the previously defined sustainability criteria, at their respective points of product development process. For example: sustainability criteria in reference to materials optimisations for manufacture can be visually associated with the beginning of the industrial timeline, and those in relation to transport efficiencies can be symbolically represented at the end.

4. *Ambiguity:* with a generic NPD process laid out along the proverbial X axis, the Y-axis can now be used to list the potential sustainability criteria defined within the previous chapter. Once ordered and grouped into category, the sustainability criteria can then be grid referenced against their respective relationships with the NPD process. This means that the user can choose any

point in the NPD process and relate it back to associated sustainability criteria, or vice versa. This provides the user with a quick method to identify potential sustainability activities within any given point of the NPD process.

6.2.1 Evaluation, Reflective and Reflexive

To provide a reflective and reflexive approach to integrating EIR activity, the 'stage and gate' method shown in figure 36 has been used, as it provides various checkpoints for the SME to evaluate project progression. To make the application of the process map more viable for SMEs, checkpoint criteria within stage and gate would need to clearly indicate the potential gains which could be obtained through use. Therefore, any contextual prompts within gate criteria would need to be backed up with guidance and benefits from procedures indicated within the process map.

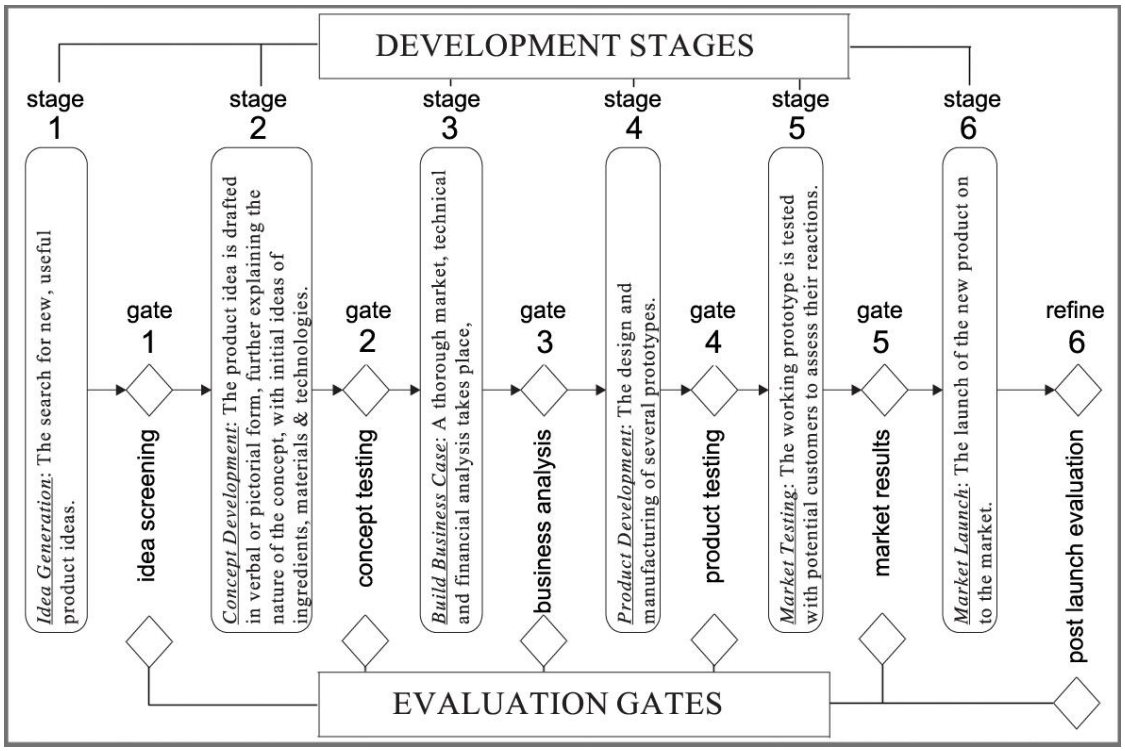


Figure 36: Adapted from Tzokas, et.al model of the Stage and Gate Process (2004).

This is why a process map for SME EIR will also work as an educational tool, which not only guides SME decision-making within the early phases of NPD, but also in relation to highlighting the benefits from further EIR engagements.

The benefits of improving decision making criteria within early evaluation gates are:

a. Raising awareness of the potential opportunities which are presented at the various phases of NPD.

b. Demonstrating how potential sustainability can parallel or compliment existing criteria for NPD progression. For example, making sustainable improvements early within product development can assist with various forms of cost reduction.

c. Strengthening the business case for more sustainable new product development and fine tuning resource optimisations to better manage decision-making in regards to SME NPD EIR.

Using a Stage and Gate approach therefore provides the opportunity to be able to integrate additional evaluative stages into the SME's NPD process. This provides opportunity for reflective and reflexive behaviour towards process map criteria, in parallel with existing NPD before moving onto the next stage of development.

6.2.3 Communication and Visual Language

The process map in Chapter 5 lacked clear visual indications in relation to where and how to place importance, ask questions and extract value from data entry. It was clear that the order of operations needed refining, while the assignment and use of colour was sporadic, distracting and lacking any visual connotation.

For further development of the process mapping technique within this area, the following criteria were applied:

1. *Use of colour to categorise:* this will be applied where elements within the map need to be indicative of actions which encourage the user to engage. For example; this will be most appropriate in drawing attention to, and highlighting the contextual differences between key elements within the map which need be considered separately.

2. *Use of colour is to initiate use:* colours which dictate current behaviour and are synonymous to everyday use should be used to the same effect. For example, contextually the colour red is synonymous with stop, and the colour green is synonymous with go.

3. *Visual clues and keys of operation:* in combination with using colour to indicate the differences between contextual elements within the map, the use of shape can also provide a visual code and provide association with key areas of the mapping process.

With the above criteria for developing user engagement, the next phase focused purely on building the knowledge base of EIR aspects to be included. Aspects of EIR activity were previously defined through the industrial survey. These key aspects have subsequently been explored in greater depth to be able to pass on the hidden value and steps for implementation, through the medium of process mapping. The development of key EIR aspects took place alongside Chapter 6 criteria for improving the mapping process. As both of these key components work together, they are therefore interdependent of each other and must complement during the use of the process map.

For example, the design of an NPD EIR process map for SMEs had to be laid out in a format which accepted the enrichment in content from each of the key EIR aspects and

demonstrated their value. This meant that the research needed to strike a balance between both the depth of information and ease-of-use when extracting EIR advice.

6.3 Design of X-Axis NPD Criteria with Stage and Gate Evaluations

The primary objective was to construct a solid and generic model of NPD with Stage and Gate evaluations. This was achieved by researching for publications with content in relation to the proficiency and execution of NPD strategies with Stage and Gate scenarios.

Content from these research papers was used to clarify the generic process and order of operations with which takes place within NPD. This then provided a generic timeline of NPD procedure with overall subject headings, which would act as a foundation.

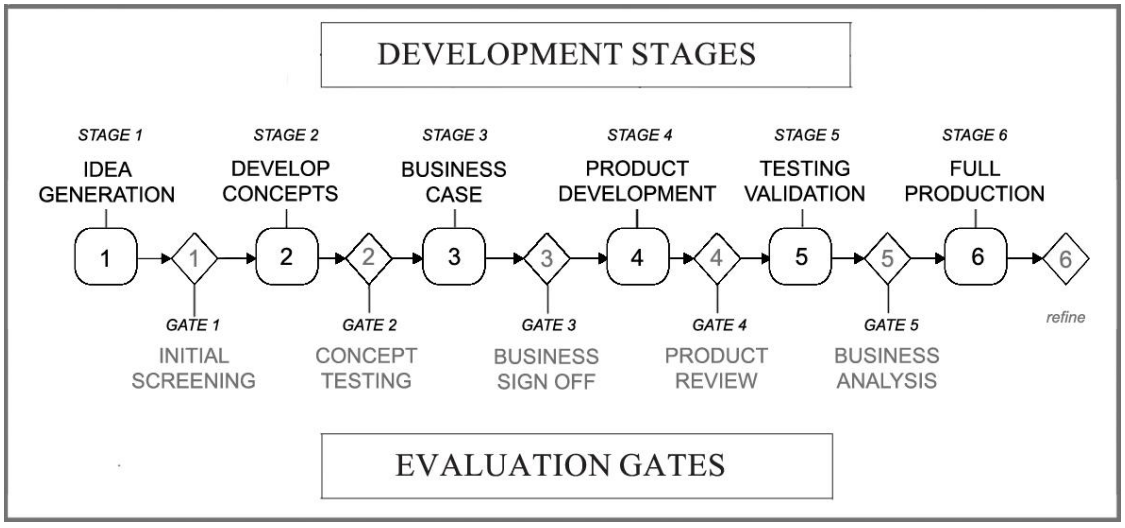


Figure 37: Generic timeline headings for NPD, with stage and gate integration.

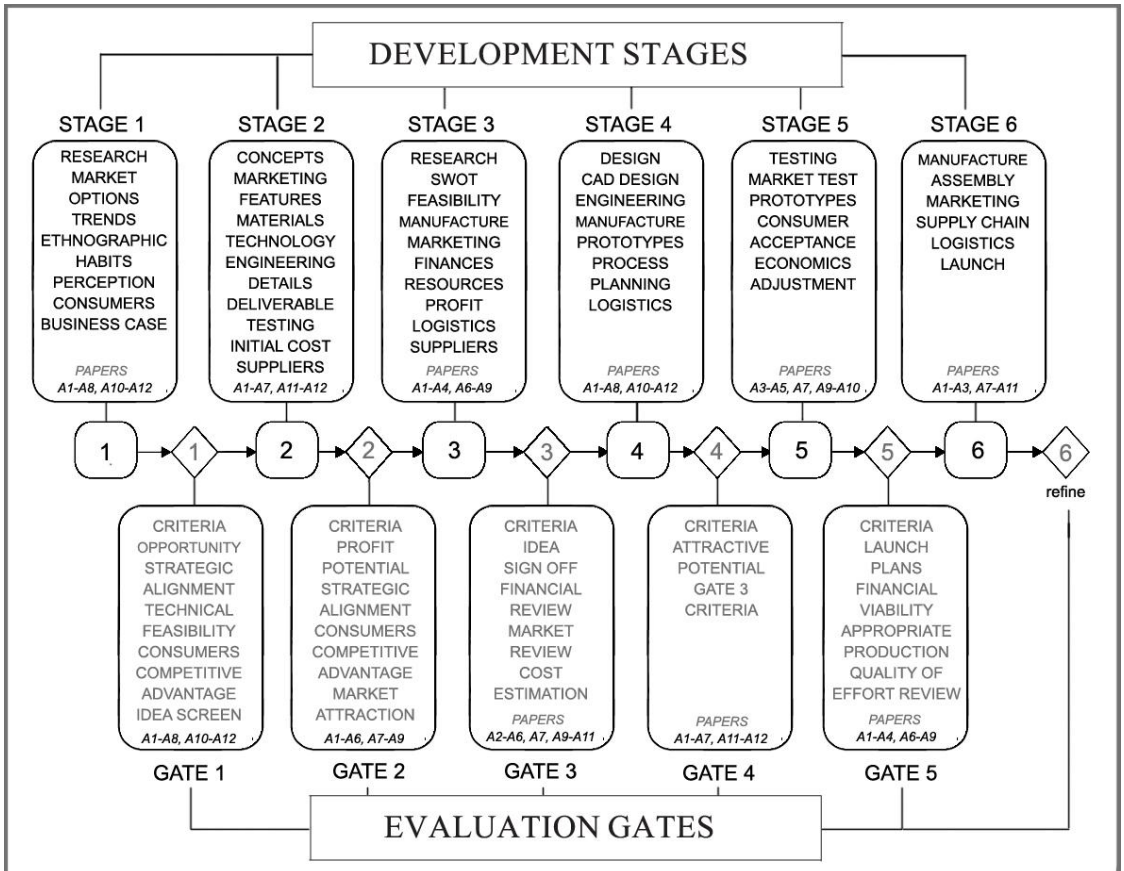
NPD project activities and sustainability criteria could then be placed at their relative position at each corresponding stage within the overall NPD process during further research. This can be seen in figure 37, where each key stage of NPD has been laid out from start to finish, with the integration of stage and gate phase titles. This format

would serve to illustrate essential criteria within the X-axis NPD timeline, to provide association for those with prior knowledge and assistance for those unfamiliar. The criteria embedded within the X-axis timeline, only serve as prompts for engagement.

In order to correlate and record the research progress, a table was drawn up to document publications in line with entering specific NPD subject criteria into the map. This can be seen in figure 38, where both of the development stages of NPD and essential criteria for Stage and Gate evaluation have been entered into the map. Within each stage and evaluation gate, a number of criteria have been laid out which encompass activities at their respective point of process.

At the base of each box are alpha-numeric's ranging from A1 to A12. These numbers represent the publications used to attain the information contained within this phase of development, and these corresponding publications can be found listed at the base of the diagram. A generic approach was achieved where the range of papers listed from A1 through to A12, shared corresponding information in relation to the type of activity and its place within the overall NPD process.

This format illustrates the composition of a generic approach to NPD with Stage and Gate, while listing the essential criteria for a step-by-step approach for SMEs. This then provided the foundation for which to begin building a new process map for EIR activity, which is rooted in current NPD practice.



A1: Kusar et al, 2003	A2: Tzokas et al, 2004	A3: Nukhet et al, 2007	A4: Kahn et al, 2006
A5: Hart et al, 2003	A6: Draft, 1998	A7:Bigliardi et al,2010	A8: Bessant, 1997
A9: Griffin, 1996	A10: Johne, 1998	A11: Ionescu, 2007	A12: Jokioinen, 2006

Figure 38: Showing full stage and gate criteria for consideration throughout NPD, and the correlating publications which share this ethos in structure and process.

6.4 Refinement and Enrichment of Essential Sustainability Criteria

With a structure laid out along the X-axis which represents a generic NPD procedure, the EIR aspects which would help SMEs to inform best practice, could now be explored in greater detail for potential inclusion within the generic NPD timeline. To achieve this, a grid reference system in figure 39 was created which enabled a comparison between the *factors of concern* defined from the industrial survey (2), and the *overall subject heading*s identified within the initial research phase (1).

Figure 39: Showing the Grid Reference Publications Map, used to generate evidence as to which Sustainability Theme of Best Practice, to resolve the most survey issues.

This grid reference system provided a focal point from which a series of filtering steps took place. This process of filtering served to isolate the most crucial, relevant and justifiable areas to be included within the final design, which would test the principle of process mapping EIR activity for SMEs with the expert panel.

The design of the grid within this phase of the research, shown within figure 39, served to achieve the following three objectives: to explore EIR key themes of best practice in greater detail; identify the themes which address the most factors of concerns for SMEs defined within the industrial survey; to group everything into six main themes for inclusion within the final process mapping tool.

These three objectives are explained in further detail:

1. The key themes of best practice which were used to construct the industrial survey were researched in greater depth. This was to identify which of the key themes would 'capture' the greatest number of factors for environmental concern, identified within the industrial survey. It was important to include key themes which would provide the widest range of improvement over EIR subject areas, to gain maximum impact through mapping use.

   This list of key themes can be seen on the left hand side of figure 39 within the area of the diagram marked with the number "1". The publications listed at the top correspond with the list of key theme subject headings on the left-hand side of the diagram, where each subject was defined in literature to be crucial for EIR. This area was then coded in blue to provide a visual language which separates the information from the rest of the diagram, in combination with the alpha numerical coding.

2. To identify which key themes resolved the most factors of concern within the industrial questionnaire. Once factors were placed along the top edge of the

diagram marked by the number "2" shown in figure 39, it was then possible to begin reviewing further publications in relation to each key theme. Where it was found that a key theme addressed the factors in more than one publication, a green tick was placed within the corresponding box inside the grid. This can be seen within figure 39 marked within the diagram with the number "3". This then enabled the indication of where certain key themes of best practice, were plausible to address a number of concerns from the industrial questionnaire.

For example, adjacent to the key theme of 'transport efficiencies', there are a series of green ticks which correspond to a number of factors directly above. In this example, green ticks indicate that two or more publications provided reference that *transport efficiency* can, amongst others, provide reductions in: packaging waste, carbon production, material reduction and costs. Publications have been listed within the top right corner of figure 39, labelled with the letter "C" and numbered from "1" to "18". This alpha numerical coding for each publication has also been placed adjacent to the corresponding key theme in reference. This can be seen marked with the number "4".

All factors from the questionnaire have been coded in green in combination with the corresponding ticks, and all publications and corresponding alpha numerical references have been coded in black, to separate this information from the rest of the table.

3. Selection for the final 6 themes considered that certain themes were connected to one another, such as: the reduction of packaging through design; the reduction in packaging waste; and the subsequent design for recycling. These areas all come under the umbrella of 'Packaging Essential Requirements',

(PER). Therefore, these three areas have been grouped into one under the heading, ‘Area 4: PER Regulations’, in figure 39.

Areas which are faded out within figure 39 are those where literature was lacking in providing detailed links between the factors and the key themes of EIR practice.

It is worth noting that the depth of knowledge within each of the key themes to be included is potentially infinite, and could stand alone as an education within itself for EIR best practice. The objective here was not to educate the SME to a totalitarian level, but simply to provide an indication towards the potential for best practice with the addition of clear incentives to engage. Therefore, rather than dictating that which needs to be known, the SME takes ownership of their own learning through the discovery and identification of their EIR needs in a way which matches their level of ability. Creating this sense of ownership holds more value than regulatory requirement, simply because the engagement is by *choice* rather than *force*.

Furthermore, aside from providing a platform for SMEs to engage with EIR, the final design aims to prove the principle that visual mapping techniques can disseminate complex data, in a more comprehensible manner. Proving the principle of using process mapping to deliver EIR best practice, can pave the way for more intricate and in-depth techniques to be included within further mapping iterations.

After refinement, the following are the final six key themes of best practice to be included within the final process mapping design. Each covers the broadest range of EIR factors for improvement, for product producing SMEs:

1. **Theme one:** Packaging Reuse Systems.

2. **Theme two:** Transport Efficiencies.

3. **Theme three:** PER Regulations (Packaging Essential Requirements).

4. **Theme four:** ISO Standards (International Organisation for Standardisation).

5. **Theme five:** Best Practices for Manufacture.

6. **Theme six:** Best Practices for working with Suppliers.

6.4.1 Enrichment of the Six Key Themes for EIR Best Practice

Further research was then conducted within each of the key themes. The objective of a further literature search for each of the six themes was to define:

a) *Actions for implementation:* what are the current steps and procedures which SMEs need to perform to implement the key themes within their current NPD activities. These actions should illustrate a range of generic procedures to demonstrate steps to engagement. Providing a range of options allows choice in terms of finding the most suitable approach. Keeping the actions generic should create symbiosis with those who understand and assist with those who do not by encouraging them in the right direction.

b) *Key Attainable Benefits:* what are the potential returns which are attainable for the investments of time and resources to engage? Each action provided needs a clear benefit obtainable to the SME for justifying engagement. A major driver for SME sustainable improvement is the education of potential gain, from any engagement with EIR activities. SMEs currently do not see the value in dedicating time and resource into activities which are outside of their current strategic objectives. Where the strategic objectives do not include EIR criteria, incentive needs to be clear to encourage them in the right direction.

c) *EIR activity placing within NPD*: finally, further literature was used to pinpoint each key theme at relevant locations throughout the NPD generic timeline

which was formally laid out in section 6.3. This enables the user to cross reference key themes of best practice against operational stages within NPD for reference and comparability.

6.5 The 6 Key Themes of EIR Best Practice for SME NPD

This section will now address the six key themes for EIR best practice, which were concluded within section 6.4 for inclusion within the final mapping design. Action / benefit descriptors will be accessed through mapping, adjacent to each key theme.

6.5.1 Packaging Re-use and Closed-Loop Systems

Packaging re-use systems aim to reduce the amount of packaging waste going to landfill by creating packaging which is adaptive for product protection on more than one occasion. Packaging designed for re-use as part of a closed-loop system, can last for at least 30 trips to and from the manufacturer and the retail destination, and often up to 100 trips or more on most occasions. Packaging used in closed-loop systems will in most instances, fall into the category of secondary packaging (collation packaging which holds the primary product); and tertiary packaging (transport packaging for delivery between manufacturer and customer), (Envirowise, GG360, 2008).

There is a significant awareness in regards to the benefits of using recycled materials, and the greater environmental benefits of taking the extra step to incorporate reusable packaging. It is also becoming increasingly apparent that in most cases there are economic gains to be made from reusable packaging being implemented to enhance transport efficiencies. The most obvious of these being cost reductions from reduced packaging consumption and waste, (McKerrow, 1996).

Actions for implementation and key attainable benefits:

- **Action:** use tertiary packaging transport containers which have the capability to stack, collapse, store effectively and return.
    - ***Benefit:*** using returnable containers which can collapse once used, can maximise space utilisation during transit, reduce packaging waste and minimise carbon contribution against overall costs of disposal.
- **Action:** assess current one trip packaging system costs, to investigate the potential for implementing new reuse packaging systems in their place.
    - ***Benefit:*** overall supply chain costs can be dramatically reduced by using packaging which is designed to be reused a number of times, in place of one trip packaging to landfill or recycling. Comparison against one trip packaging systems can highlight dramatic minimisations in material and disposal costs.
- **Action:** utilise the potential for using adaptable crates for variable product sizes, rather than one size for all products.
    - ***Benefit:*** using adaptable crates can provide reduced measures for product handling times during transit, and required storage measures.
- **Action:** lease reusable containers for product transit, instead of purchase.
    - ***Benefit:*** minimisations can be achieved in purchase costs and streamlining efficiency of packaging usage.
- **Action:** specify the use of recyclable and recycled materials to be used in the design and use of potential reuse systems.

- ***Benefit:*** potential reductions can be achieved in raw material usage and subsequent waste disposal costs once transport packaging has expired.

- **Action:** use third-party organisations to run and manage your packaging reuse scheme.

    - ***Benefit:*** knowledge and capacity of third-party organisations can provide intrinsic value to maximising efficiency, saving time and personnel resources.

(Envirowise, GG360, 2008; Envirowise, GG980, 2008; McKerrow, 1996; NI Business, 2009; WRAP, 2010; WRAP, 2007; Seitz, 2004).

6.5.2 Transport Efficiencies

If packaging re-use is not appropriate for SME requirements, then a refined one trip packaging solution should be considered. A one trip packaging solution would be packaging which is not intended to be returned to the manufacturer, but has a final destination to either: landfill, energy recovery or recycling processes, (Envirowise, GG360). Implementing effective one trip packaging solutions will require an attention to detail in relation to resource minimisations. Resource minimisation is an umbrella term which covers a range of sustainability criteria in relation to: materials usage, energy requirements, and transportation impacts upon costs and the environment, (Saghir, 2004).

Packaging specifications not only influence timescales required for completion of packaging operations, but around one third to two thirds of an organisation's logistic expenses are dedicated to transportation costs, (Tseng, 2005). Therefore, where considerations are placed within secondary and tertiary packaging used within

transportation, i.e. protective packaging, palettes and roll cages; transport unit adaptability is highly considered the most important factor with a view to maximising efficiency, (Hellstrom & Saghir, 2006; Saghir and Jonson, 2001).

Actions for implementation and key attainable benefits:

- **Action:** maximise secondary packaging efficiency requirements in relation to product protection, by avoiding unnecessary utilisation of space for point-of-sale applications.
    - ***Benefit:*** improved handling conditions for workers throughout the supply chain logistics, reducing time and effort involved for loading and offloading product throughout the various supply chain networks.
- **Action:** maximise tertiary packaging efficiency requirements in relation to palette protection during transportation, by designing secondary packaging which interlocks and is self-supporting, therefore requiring minimal palette protection material.
    - ***Benefit:*** Improves volume efficiency of product per pallet, and large reductions in waste tertiary packaging disposed of within each stage of the various supply chain networks.
- **Action:** increase density of protective packaging, either within secondary packaging, tertiary packaging, or both, by considering the overall structure of the materials used for transportation.
    - ***Benefit:*** higher density materials are essentially more compact and rigid, therefore these materials can decrease the overall size of packaging used for transport improving cubic utilisation of space. This therefore allows more products to be stacked per pallet increasing

product take-through and reducing number of transportations required per volume order.

- **Action:** adapt variations in pallet size in relation to product and type being transported within supply networks.
    - ***Benefit:*** Gauging the feasibility of required pallet sizes against products to be shipped can improve cubic utilisation of space. This therefore allows more palettes to be loaded, reducing the number of transportations required per volume order.
- **Action:** consider stacking ability and shape adaptability of protective secondary packaging when considering pallet space utilisation. Consider the density of materials and how this density can be leveraged to enable products to be stacked and interlocked to save space, improve rigidity and reduce potential product damage.
    - ***Benefit:*** facilitates efficient handling at all points of supply chain loading and offloading of product, improves cubic utilisation and reduces the need for excessive packaging and waste. Reductions in product damage and returns, overall costs, potential waste and carbon contributions through improved transport efficiencies.

(Lambert et al, 1998; Hellstrom & Saghir, 2006; Klevas, 1998; Chan et al, 2005).

6.5.3 Fit For Purpose Packaging Design, PER Regulations

To enable the streamlining of packaging which enhances transport efficiencies, guidelines within the PER regulations encourage packaging to be fit for purpose through design. Due to a lack of awareness at an SME level, the PER regulations have

a tendency to be overlooked by organisations, or seen as an additional task which bears little significance to the organisation. In fact, the PER regulations in guiding packaging designed to be fit for purpose, potentially offer many returns other than simply being compliant with environmental obligations.

Actions for implementation and key attainable benefits:

- **Action:** through design, balance material usage against the specified required protection which the product needs during transportation.
    - ***Benefit:*** Choosing the correct materials, density of the packaging as appropriate design in relation to required protection, reduces the use of unnecessary materials, improves stacking, cubic utilisation and overall handling throughout logistics.
- **Action:** provide the inclusion of recyclable and recycled materials during the specification process of packaging design.
    - ***Benefit:*** reduced costs and streamlined material usage which promotes the recovery of raw materials and boosts environmental profile.
- **Action:** reduce the inclusion of hazardous and noxious substances within packaging construction.
    - ***Benefit:*** improved environmental profile with a more sustainable attitude towards material usage, and the potential of reduced fines as a result.
- **Action:** seek to obtain product packaging technical legibility documentation from your suppliers and packaging producers.

- ***Benefit:*** raising interests in attaining documentation, pressures suppliers to adhere to potential regulation requirements. This ensures that there are no hidden agendas and that SME organisations are informed clearly with what they are getting. Additionally, technical legibility documentation can be provided as evidence to the trading standards organisation that packaging is compliant with obligations.

- **Action:** limit and reduce the amount of transit and college and packaging prescribed for supply chain logistics, and seek alternative ways to protect overall product transportation.

    - ***Benefit:*** a reduction in superfluous packaging used within the logistics chain between manufacture and retail delivery will essentially lower overall disposal costs, reduce waste and streamline cost efficiency.

(Wilson, 2010; Envirowise GG360, 2008; Envirowise, GG980; Holdway et al, 2002).

6.5.4 ISO 14001 / ISO 9000 Accreditation

In order to set the foundations for more informed discussions with suppliers in relation to the criteria for packaging fitness for purpose design, it is worth considering if the suppliers have been accredited to any of the ISO international standards. The International organisation for standardisation, (ISO) is the managing body which aims to provide services within the quality of environmental management systems (EMS) to industries across the globe.

The certifications they provide are known as the ISO Standards, and are accredited to organisations who apply for them when certain criteria are proven to be met by the applicant, (Bansal & Hunter, 2003; Link & Naveh, 2006). The certifications for both

the ISO 9001 and ISO 14001 series of standards essentially differ in their criteria, but have both been proven to increase commercial status and profitability of the organisations with which choose to implement them as part of their strategic objectives, (Bansal & Hunter, 2003' Rondinelli & Vastag, 2000; Poksinska et al, 2002; Link & Naveh, 2006).

The main differences between the two standards of ISO 9001 and ISO 14001 originate from the criteria with which each of the standards requires for accreditation. Holding a certification for the ISO 9001 standard demonstrates that various aspects of quality management procedures have been adhered to. The standards require that companies and organisations ensure that their products and services consistently meet their customers' requirements and that quality in design, manufacture and delivery is consistently improved. Holding an ISO 9001 accreditation, potentially shows your customers that key areas of quality management systems; organisational performance; responsibility of management; and resources are being consistently measured, analysed and improved, (Poksinska et al, 2002; Link & Naveh, 2006).

Holding a certification for the ISO 14001 standard demonstrates that due care and attention is being paid towards the responsibilities within the organisation for environmental management. This standard is designed to assist organisations as a plan for, and to assist with the implementation of in-house EMS, which continuously monitor the way in which a company operates in regards to its use of resources and its targets for sustainable improvements, (Morrow & Rodinelli, 2002; Bansal & Hunter, 2003; Rondinelli & Vastag, 2000; Poksinska et al, 2002; Link & Naveh, 2006).

These two standards, although different in application, both intend to improve the overall outputs of the organisation internally and externally. ISO 9001 provides guidance in relation to delivering a product or service that satisfies the customer's

needs and requirements, by improving operations internally within the company. ISO 14001 purely focuses on the need to protect the environment and set up management systems which control those activities which could significantly place an impact on the environment. From the perspective of the SME customer, this therefore indicates an assurance of quality and a reliability that the organisation they will be dealing will endeavour to meet all expectations outlined within the ISO standards, and will subsequently pass these benefits on to the customer.

If SME product producers by way of encouragement through the process mapping technique begin to enquire as to the accreditation of their current suppliers, this choice will be one step closer to them understanding the importance of ISO and asking more informed questions.

Actions for implementation and key attainable benefits:

- **Action:** check to ensure that packaging vendors and suppliers are registered and additionally certified with the ISO standards, being that either of ISO standard 9001, or more importantly, ISO standard 14001.
    - ***Benefit:*** supplier certification will demonstrate a continual dedication to improving performance within resource efficiencies and the ultimate reduction of costs, which can be passed on to the customer.
    - ***Benefit:*** supplier certification to the ISO standard 14001 will demonstrate proficiency towards environmental sustainability, and dedication towards the reduction of unnecessary waste through production and delivery.
    - ***Benefit:*** supplier certification to the ISO standards will indicate a conformance to all regulation procedures and obligation. In the

instances where SME organisations lack competency, ISO can provide assurance that suppliers can manage these obligations on behalf of the SME client, or inform them of such requirements.

(Morrow & Rodinelli, 2002; Bansal & Hunter, 2003; Rondinelli & Vastag, 2000; Poksinska et al, 2002; Link & Naveh, 2006).

6.5.5 Initial Best Practice for Environmental Manufacturing

In terms of SMEs beginning to improve the overall levels of communication with their suppliers when designing new packaging and products, the context of the discussions should essentially be a two-step process. In the first instance it would be essential for the SME to assess their supplier against set criteria, which they declare to be in line with their strategic objectives. This then enables the SME to assess their position with the supplier in relation to the quality which they receive as a customer and begin to specify where they feel improvements can be made in line with their objectives. Working in this manner provides a situation where both parties are informed with what is required and expected, and what can be offered and delivered. In some instances this will be essential, where customer firms may be liable for their purchased products and services which are passed on to them by their suppliers (Hall, 2000).

In the second instance, if following the initial assessments and collaboration, suppliers have failed to meet the specified criteria, it may deem relevant to put into operation steps which will encourage the suppliers to adhere to options which better suit the SME. This then gives SMEs more control and purchasing power within their supply chain networks, rather than being at the mercy of their suppliers, and will be discussed in finer detail within section 6.5.6. If an SME is to begin improving internal sustainability targets, assessment of supply chain partners is essential. This is because

a high performance SME may essentially be affected by a poor level of environmental management from their direct suppliers, (Faruk et al, 2002). Additionally, assessing environmental management within the supply chain may also present an uncapped avenue for further reductions of supply chain costs through more efficient use of natural resources, (Hart, 1995; Florida, 1996).

Collaboration here is essential for SMEs, as suppliers will have a direct impact on the critical dimensions of cost, quality, technology, delivery, flexibility and potential profits (Dayna et al., 2005). This means that for SMEs, well structured and routine supply chain collaborations can encourage a joint approach to problem-solving, which can lead to reductions in costs and improvements through the importation of new and critical knowledge, (Lamming, 1996; Krause et al., 2000; Dyer & Nobekoa, 2000), in which SMEs are currently lacking.

Essentially, the benefits of assessing your suppliers can be reciprocal for both the manufacturing and environmental performance of firms, where a joint approach will lead to better product design and process efficiencies, which in turn can lead to overall waste reduction and innovations (Dayner et al., 2005). Additionally, it is important for SMEs to understand the mechanics behind the products with which they purchase from their suppliers, as the manufacturing system is where the greatest amount of pollution may be generated by firms and where the highest volume of resources are consumed (Florida, 1996; King & Lenox, 2002; Kitazawa and Sarkis, 2000).

With SMEs beginning to assess their suppliers against a set of criteria, a system can be generated which is well organised and devoted to continuous improvement and elimination of all forms of waste (Dayna et al., 2005). Encouraging this behaviour within SMEs will be one step closer for SMEs to begin applying for ISO accreditation. The ethos of ISO standards requires the behaviour to continuously refine and improve

one's processes. Encouraging this with suppliers who are also credited with ISO may then be reciprocal for the SME once the benefits of collaborative improvements are realised.

Actions for implementation and key attainable benefits:

- **Action:** obtain information from suppliers in relation to the essential production processes required for packaging production, and the associated costs with which are incurred by each of these processes.
    - ***Benefit:*** Education here will begin to encourage consideration towards the quality of production methods and potential improvements which may be available.
- **Action:** begin to initiate collaborative efforts with suppliers to seek improvements in relation to the production processes and associated costs defined within the first phase of assessment.
    - ***Benefit:*** amongst others, this will improve the efficiency of raw material used within the packaging production processes, if streamlining can be achieved within the given and current procedures.
- **Action:** begin to initiate collaborative efforts with suppliers to seek improvements in relation to your environmental targets and strategic objectives which may have been defined within the first phase of assessment.
    - ***Benefit:*** this may provide the potential for overall reductions of costs and fines to be incurred through packaging design, and or, reductions in overall packaging waste production.

- ***Benefit:*** discussing environmental targets and responsibilities with suppliers, will improve the response time to, and the adoption of new regulation procedures and obligations placed upon the SME.

(Hall, 2000; Faruk et al, 2002; Dayna et al., 2005; Krause et al., 2000; Dyer & Nobekoa, 2000; Florida, 1996; King & Lenox, 2002; Kitazawa and Sarkis, 2000)

6.5.6 Supplier Development Strategies

With SMEs beginning to define what can be achieved through environmental improvements with their suppliers, they can begin to refine what is achievable within the remit of their core competencies. Therefore, it is essential that suppliers are able to deliver that with which the SME requires, as the SME is essentially dependent upon the supplier to deliver.

This process of evaluation is essential in a competitive market for an SME, they must ensure that their suppliers performance and capabilities are equal to or greater than, the performance and capabilities of the SME firms competitors (Krause, 1997). If a suppliers performance and or capabilities through assessment have proven to be deficient within, for example: delivery, cost reduction, adopting new technologies or handling design issues; then the facilitation of supplier performance and capability improvements through supplier development may be appropriate (Handfield, et al, 2000; Dayna, et al, 2005; Krause, 1997).

Supplier development efforts do not necessarily need to be intensive. Understandably at the upper range of efforts, this may involve such things as training suppliers' personnel and investments in the suppliers' operations, but initially, at a lower level this process can begin to take shape with some simple informal evaluations and

requests for improved performance (Krause, 1997, Krause, 2000; Handfield et al, 2000).

Where responses from the suppliers may not be satisfactory to the SMEs criteria, firms may use a variety of basic activities to begin encouraging performance and capability improvements from their suppliers. Some of these encouragement activities may include such things as introducing direct competition; further evaluations against tougher criteria; raising performance expectations and recognising good performance; and the promise of future benefits and custom upon adhering to the requests of the SME customer (Chan, 1990; Monczka, 1993).

Giving SMEs the ability to make an impact within their supply chains, and drive competition amongst suppliers can essentially foster performance improvements, while involving no commitment to the second buyer (Krause, 1997). Therefore, increased volume allocations and considerations for future business contracts as an incentive for supplier performance increases in line with SME EIR objectives, may essentially begin to give SMEs back the control which they currently lack.

Actions for implementation and key attainable benefits:

- **Action:** conduct an informal assessment of supplier operations and current performance statistics in line with SME expectations, and or, ambitions.
    - ***Benefit:*** begins to orientate the SME towards the understanding of and improvement within the current manufacturing performances with their supplier.
- **Action:** raise performance expectations of the suppliers in areas with which they meet and also failed to meet the criteria in line with SME objectives.

- ***Benefit:*** overall performance expectations can improve technical designs and delivery of quality product, making numerous cost savings throughout production and delivery.

- **Action:** provide future benefits and incentives for suppliers to improve, in line with environmental strategic objective criteria provided by the SME, informed by the previous activities.

    - ***Benefit:*** amongst others, for example, benefits may reside in project completion times and turnaround timescales with product design and delivery.

- **Action:** introduce the potential for competition from other suppliers, where the current supplier does not meet the required expectations of the SME.

    - ***Benefit:*** introducing competition can essentially mean the loss of business for the supplier. Therefore, applying this pressure can bring benefits within a host of areas, essentially those defined by the SMEs requirements. If a direct competitor to the supplier can offer an equal service at a cheaper cost or within a tighter timescale, it may well be the SME's best interests to challenge their loyalties.

(Krause, 1997, Krause, 2000; Handfield et al, 2000; Scannell et al, 2000; Dayna et al, 2005; Hanfield & Nichols, 1999; Chan, 1990; Monczka, 1993).

The key themes of best practice which have been illustrated above through sections 6.5.1 – 6.5.6, aim to encompass a broad range of environmental best practices which are feasible for SMEs to begin associating themselves with.

The order with which they have been laid out is reflective of the amount of effort required to engage with each, beginning with initial considerations in regards to

packaging logistics for their customers, and ending with potential restructures within supply chain commitments. Laying these elements out in sequence will not only help to educate the SME within each area and the order with which each can happen; but will enable consideration towards an area that matches their NPD development and / or level in ability.

Section 6.6 will now explain the process with merging both the generic NPD framework and the key themes of EIR best practice for SME sustainability.

These elements will be brought together through a process mapping technique that leverages visual language to help communicate the order of importance of key themes contained within the map in line with generic NPD.

6.6 Final Design: SME NPD Process Mapping Framework for Sustainability

The decision was made to extend the original generic timeline of NPD from figure 38, to cater for the additional key themes defined in section 6.5, such as transport efficiencies and logistics.

6.6.1 Post Manufacture Logistical Chain Activities

The original image shown in figure 38 illustrated the generic NPD timeline with the inclusion of full stage and gate criteria up to the point of manufacture. To extend the process map to include activities which are post-manufacture, a further addition is required to enable SME organisations to be able to process map sustainability right up until the point of retail. Incorporating the whole product development timeline, from initial concept ideation right through until retail delivery, enables the SME to encompass the whole product development process, and the breadth of opportunity.

The following diagram in figure 40 illustrates a continuation of figure 38.

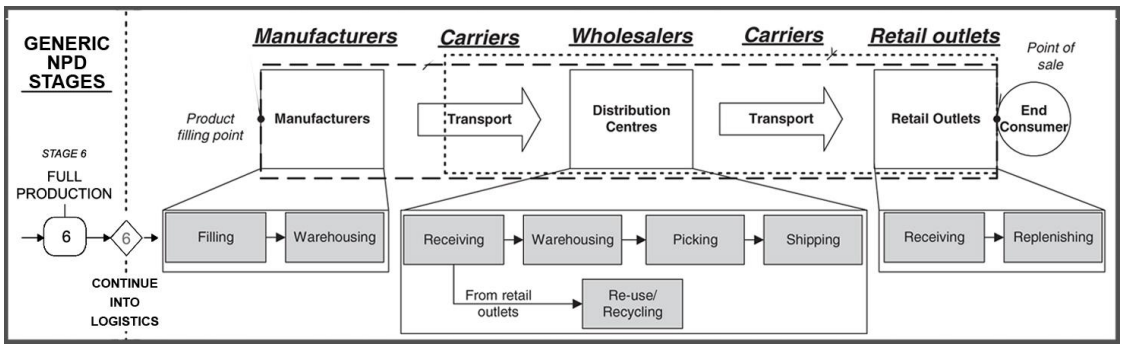


Figure 40: Showing the addition of logistics operations added on to the original generic NPD timeline, shown in figure 38, adapted from Hellstrom & Saghir, 2006.

Figure 40 incorporates the additional logistical operations of, product filling, into packaging for shipment, transport activities, warehousing and storage, loading and offloading of product, handling / picking, and retail product replenishment.

When constructing the generic NPD timeline there will be no single procedure which every company will follow to bring a product to market. Organisational proficiency will vary so a generic NPD timeline is proposed to cater for those with less knowledge by indicating correct procedure, while creating a symbiosis with those who are more associated.

So as to remain consistent with this philosophy, the additional packaging logistics diagram to be included within the process map will also be generic. Each company may have a number of wholesalers and retailers, each of which will involve transportation of their products. Therefore figure 40 lists the general activities within logistics as a point of reference for the SME.

6.6.2 Subject Heading Groupings for NPD Development Phases

Due to the complexity which was presented in matching EIR criteria against NPD and logistics, it was essential to break the system down into more manageable chunks. Therefore, the stage and gate development phases shown in figure 38, and the logistics processes shown in figure 40, were grouped into three main categories.

This process of grouping the information enables the content within the map to work as a series of headings and subheadings.

6.6.3 Front End Innovation and Strategic Concept Development

This heading includes the following subheadings below, shown in figure 41:

- **Phase 1**: Idea Generation.
    - ***Gate 1**: Initial Idea Screening.*
- **Phase 2**: Development of Concepts.
    - ***Gate 2**: Concept Testing.*
- **Phase 3**: Business Case.
    - ***Gate 3**: Business Sign-Off.*

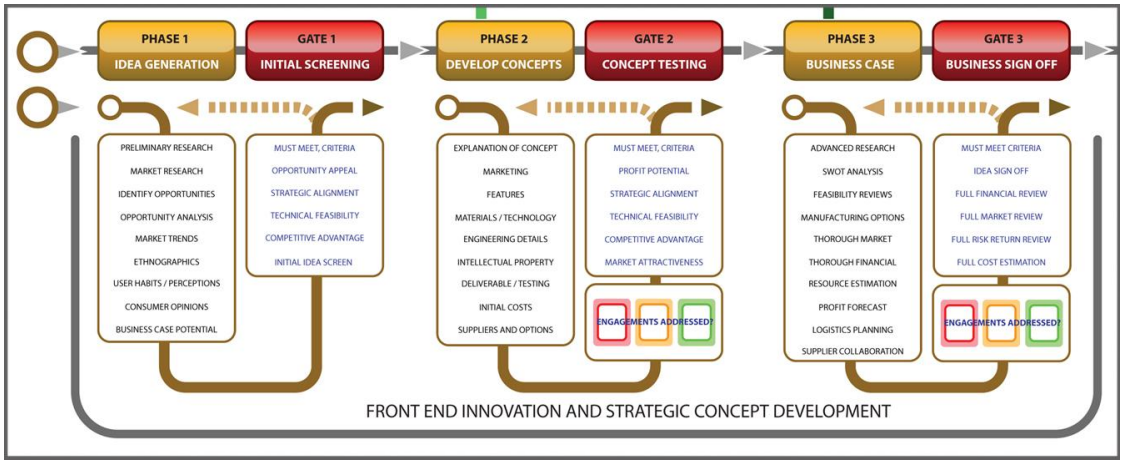


Figure 41: Front End Innovation and Strategic Concept Development Stage.

This first grouping of subject areas encompasses the activities in relation to the conceptualisation, investigation and subsequent justification of potential product avenue. Within these first three key phases, a series of investigative loops takes place within NPD, where each loop generates a stronger argument for further development. If all criteria are met at the end of each phase, then an argument can be presented to continue development. These phases above in figure 41 represent these stages of development.

6.6.3.1 Design and Visual Language for Each Subject Heading

Phases 1 through to 3 have been represented within small boxes at the top of figure 41. Each of these boxes has been coded with **orange** to create an association with each phase being synonymous, with the overall subject heading. In this instance the subject area is: *'Front End Innovation and Strategic Concept Development.'*

In both figure 41 and figure 43, appropriate colour has been assigned to each development phase within NPD. For example, all phases within *'Front End Innovation and Strategic Concept Development'* are coded with **orange**, whereas all phases within *'Product Development Detailing and Analysis',* shown in figure 43, are coded with **green**.

Adjacent to these is another box which represents each of the *'Gate Assessments'.* The Gate Assessment boxes have been coded with **red**, and this coding has been continued throughout the generic NPD timeline.

The decision to use **red**, **orange** and **green**, is to create a visual association. For example, all areas coded with ***red*** indicate a ***stop*** in the process where considerations need to be made. All areas coded with ***orange*** indicate the ***intermediary*** stage of preparation and all those coded with ***green*** indicate a ***full commitment*** is taking place.

All criteria in relation to each ‘Phase’ and each ‘Gate’ are located directly below each Phase and Gate heading. ‘Phase Criteria’ is illustrated in ***black***, and *‘Gate Criteria’* is illustrated in ***blue,*** to visually separate these two elements.

All boxes which contain criteria are connected with an arrow which indicates flow. Flow is in relation to the order with which tasks must operate within a series of steps. In this instance the arrow begins by drawing the user down through ‘Phase 1 Criteria’ (in **black**) and subsequently back up and round to ‘Gate 1 Assessment Criteria’ (in **blue**). This can be seen in figure 42.

At the top of each criteria box are two arrows, one to the left and one to the right. The arrow which is a lighter dashed colour indicates refinement in Phase 1 should be considered, where assessments are not satisfactory.

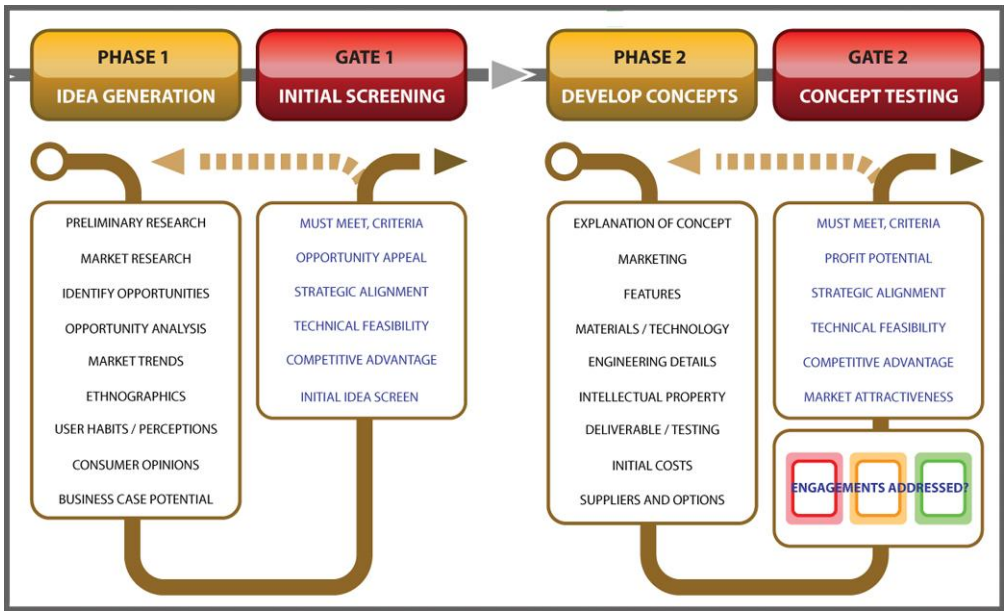


Figure 42: Showing the narrative of operations as a flow diagram with arrows.

For example, when assessment identifies that not enough business case potential has been identified within *‘Idea Generation’*, it may be deemed necessary to conduct further market research before moving onto the next phase of concept development. Progression is indicated in figure 42, by the darker coloured arrow pointing to the

right. Directly below Gate 2 '*Concept Testing Criteria'* in figure 42, can be seen an additional box with three coloured segments with the title, '*Engagements Addressed*?' This small box represents the first instance where sustainability key themes can be brought into NPD. This small check-box with **red**, **orange** and **green** segments contained within it, serves as a prompt, to incorporate sustainability criteria within the Gate 1 assessment. One of these checkboxes has been placed at every one of the gate criteria, leading up to the point of full manufacture. These checkboxes encourage the user to begin to make comparisons between the value embedded within the sustainability section of the process mapping tool, and their own NPD criteria. For example, it may be that one of the sustainability key themes defined within section 6.5 holds additional value which had previously been overlooked within the initial SME strategic objectives.

The relevance of this exercise is to encourage the SME users to identify further areas for consideration, which can be included alongside their standard assessment procedures. The intention is to change the behaviour of the SME so that they begin to consider sustainability and environmental best practices, throughout each phase of NPD. Therefore, elements such as: engineering details, materials and technology, initial costs, suppliers and options, product features and marketing, etc, within figure 42, could all essentially share improvements through asking more informed questions.

For the user to verify that the process mapping tool has been used to maximise potential value at each development phase, the checkbox contains three columns:

1. *Column 1* in **red** indicates that attention is still required with assessing existing product development criteria, against sustainability value contained within the process map.

2. *Column 2* in **orange** indicates that the sustainability areas have been considered against NPD criteria, and at this time the potential improvements offered are currently unsuitable.

3. *Column 3* in **green** indicates that the value within the existing process map has been considered in relation to NPD criteria, and that currently no further investigation is required before outlining objectives for the next phase.

These checkboxes have been placed preceding Gate 2 and Gate 3, to provide the following benefits from the process mapping tool:

- Phase 2: at this stage of product development all ideas are being considered in relation to outlining the product structure and design including all materials and processes. Considering EIR at this phase will enable the potential reduction of costs and improve manufacturing and logistics by working with suppliers, through asking more informative questions. Enhancement here can strengthen the technical feasibility of the product, its strategic alignment with company objectives, and develop competitive advantage and market attractiveness.

- Phase 3: at this stage of the NPD, the business case is being put forwards. Considerations here revolve around manufacturing options and feasibility, financial, market and resource estimations with profit forecasting and logistics and supply planning. Considering EIR at this phase will enable the strengthening of for-and-against decision-making, against existing product criteria in parallel with sustainability areas. Sustainable enhancements here can strengthen full cost estimations before moving into product development.

6.6.4 Product Development Detailing and Analysis

This heading includes the following subheadings below, shown in figure 43:

- **Phase 4**: Develop Products.
    - ***Gate 4**: Product Review.*
- **Phase 5**: Testing and Validation.
    - ***Gate 5**: Business Analysis.*

The second grouping of subject areas shown in figure 43, encompass activities in relation to all design, development, testing, prototypes and preparation for full manufacture and production.

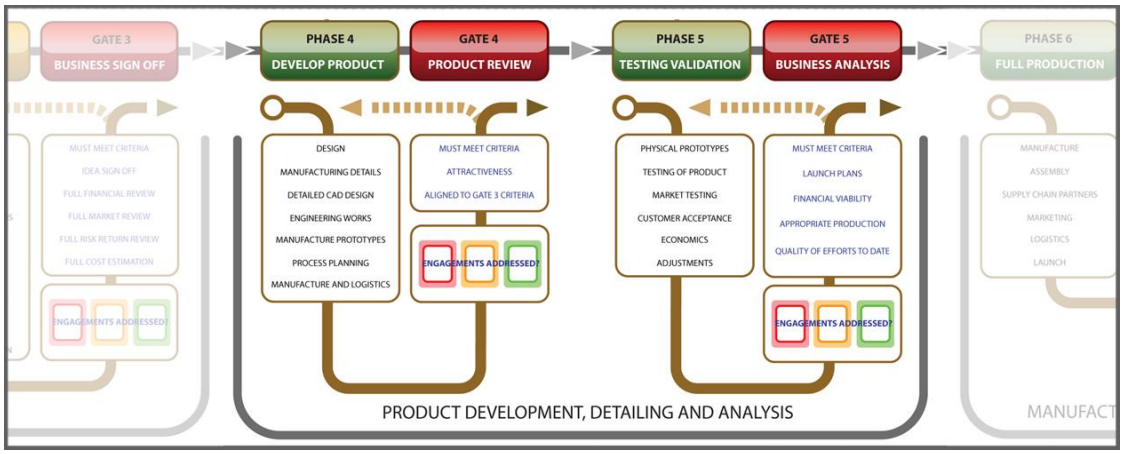


Figure 43: Product Development Detailing and Analysis Stage.

Decisions have been made that there is a justifiable argument that a product is required and that a market exists for that product. At this stage of NPD, large amounts of time and resources are invested into bringing the product to fruition.

At this phase, changes to the product can still be made and if deemed necessary, product development can be stopped through failure to meet the Gate 4 and Gate 5 criteria.

Checkboxes are placed prior to Gate 4 and Gate 5 to provide the following benefits:

- Phase 4: at this stage of product development a full design manufacturing and detailing will take place including detailed CAD design, engineering works and manufacture prototypes, process planning and logistics. Considering sustainability at this phase will enable considerations towards logistics and packaging designs, following on from previous discussions with suppliers during concept development. All elements of sustainability contained within the process map can provide numerous and reciprocal reductions in benefits throughout the areas of manufacture, transportation and environmental obligations activities within this Phase.

- Phase 5: at this stage the final tweaking is being conducted to ensure that the final product offering meets all expectations throughout the entire product development process. Final assessments here encompass routes to market and final financial assessments for viability in profit. There are still opportunities at this stage to consider sustainability, although the effectiveness of those choices to be made are more suited towards the initial concept development stages of NPD, rather than the closing stages prior to full production.

6.6.5 Manufacture / Launch / Wholesale / Distribution / Retail

These headings include the following subheadings below, shown in figure 44:

- **Phase 6**: Full Production.
- **Phase 7-9**: Packaging Filling; Warehouse Storage; Transport to Wholesale.
- **Phase 10-13**: Wholesale and Warehouse Storage; Picking and Distribution.
- **Phase 14-15**: Received at Retail for End Customer; Further Orders Placed.

The final grouping of activities shown in figure 44, encompass each stage following on from NPD, where essentially no more decisions can be made in relation to the product structure and design.

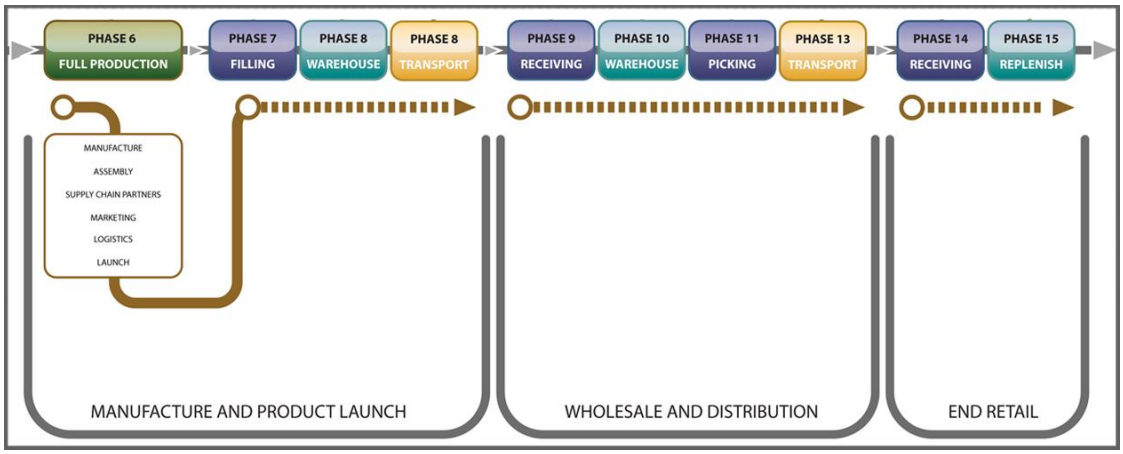


Figure 44: Manufacture, Product Launch, Wholesale, Distribution & Retail stages.

As mentioned in Chapter 2, 80% of the environmental impacts of a product are decided within the initial stages of design and development (Wilson, 2010). This makes it crucial to consider sustainability early on within the NPD process. That is not to say though that the final logistical stages are not as equally important, quite the contrary. This is because the decisions made in the early stages of NPD, take most effect during the final stages illustrated in figure 44.

For example, impacts upon the environment due to the choices made in relation to the materials used, will affect the manufacture of the product and the packaging volume in these final stages. These choices will affect the efficiency of how these products are handled, stored and distributed within the logistics supply chain as a result. For this reason the process mapping tool illustrates these final stages to be able to create a synthesis with how choices made at the beginning of NPD, have longevity far beyond the board-room. This will help to enable the SME to appreciate the life cycle of the intended product.

6.7 Integration of all Sustainability Key Themes into NPD Process Mapping Framework for SME Sustainability

The difficulty with the process mapping of a wide range of criteria into a single framework is not so much in relation to where these elements relate to NPD, but more in relation into how the user perceives a benefit by actively engaging in the mapping process.

Therefore, process mapping activity requires that the order of steps be logical in approach and coded in a way which avoids ambiguity within the data. This then presents a course of engagement which reinforces the value contained within.

This requires the EIR data contained within the process map to be presented in a context of an argument. Presenting the data in the context of argument requires each set of EIR criteria to be broken down and presented as a narrative which highlights exactly where benefit can be obtained.

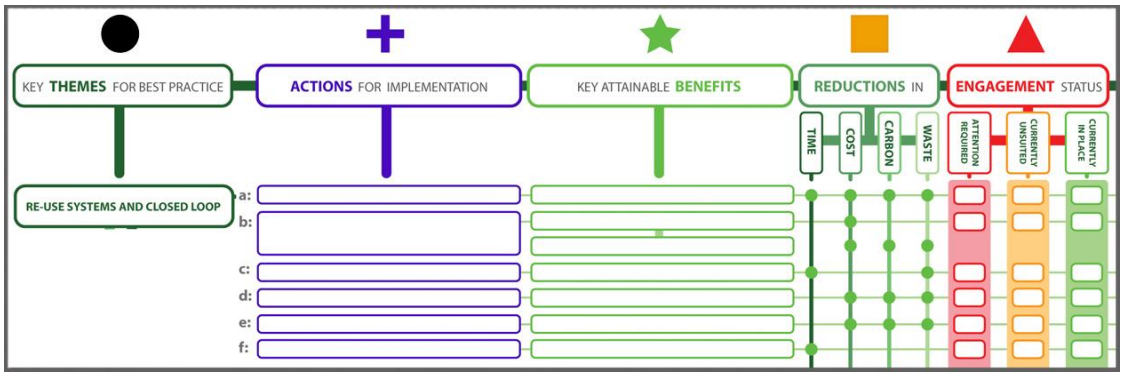


Figure 45: Demonstrating the series of steps which will guide the user through the argument for sustainability, supported by actions and benefits for each key theme.

Providing a stepped layout guides the user through the argument for each sustainability theme, and brings them to potential insights through assessment of the factors. This process aims to encourage engagement and subsequently indicate where improvements can be made, shown within figure 45.

Visual language was implemented to create associations within each step of taking the user through each consecutive theme. This is done by using both colour and symbol to differentiate areas that require user engagement, shown in figure 45. This coding has the potential for later use within further mapping documentation, where these same colours and symbols could be used to facilitate association.

The series of steps included within the map, shown within figure 45, are as follows:

1. **The overriding key themes for best practice:** these are the main key themes which were defined in section 6.5, which guide the user through a series of EIR practices. These range from simplistic improvements in packaging design, through to self-assessment and supplier selection. This element of the process map can be seen in figure 45, highlighted by the "**black** circle" above the heading. These originations of these themes were discussed in section 6.4.

2. **Actions for implementation:** these are the required actions which must be carried out in order to effectively implement the key themes of EIR practice. These list a series of activities which endeavour to achieve proficiency within the chosen key theme. This will be to educate the SME, and / or initiate discussion in relation to implementation. This element of the process map can be seen above in figure 45, highlighted by the "**blue** cross" above the heading. These originations of these actions were discussed in section 6.5.

3. **Key attained benefits:** each action listed is directly attainable to a benefit which can be achieved as a result of engagement. In order for SMEs to see the value embedded within the EIR practices, there has to be a clear indication of obtainable benefit through their investment. This element of the process map can be seen above in figure 45, highlighted by the "**green** star" above the heading. The originations of these benefits were discussed in section 6.5.

4. **Reductions:** to create a synopsis for use and quick reference for the SME, each action and accompanying benefit for each key theme can be rounded down to a reduction in either some or all of: *time, cost, carbon, waste.* This enables the SME to dip in and out of the map quickly. For example, if they wish to find activities which solely rely on the reductions of *'cost',* then this can then be identified through this channel. This element of the process map can be seen above in figure 45, highlighted by the "**orange** square" above the heading. The originations of these reductions have been discussed throughout section 6.0.

5. **Engagement status:** one of the most important parts of the mapping process is the opportunity to change the behaviour of the SME user. Part of the behaviour change to embracing EIR practices has to come from a process of personal engagement and assessment. Encouraging the user to engage with the process creates a sense of ownership and makes the learning process elaborative.

   If there was no opportunity for engagement present within the map, then the process would be no different to that of using a book. Giving the SME the opportunity to engage, document and then record data within the framework, deepens the process of learning makes the activity more tangible.

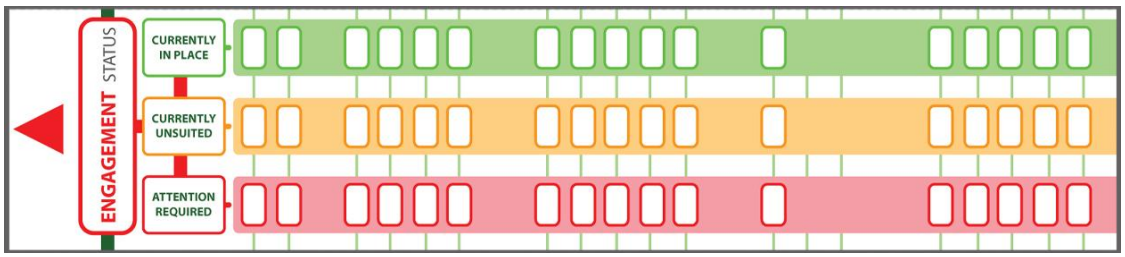


Figure 46: Demonstrating the three areas of engagement, with which the SME will personally assess themselves against when working through the process map criteria.

This element of the process map can be seen below in figure 46, highlighted by the "**red** triangle" above the heading. The engagement status area is separated

into three different categories, each labelled with a colour which aims to indicate the overall response from the SME. The three areas are shown in figure 46 and are as follows:

- **Attention Required:** *coded in red;* through evaluation of the adjacent EIR criteria, the SME will place a mark here if they are currently not engaging with the activity, but identify it will be of benefit to do so.
- **Currently Unsuited:** *coded in orange;* through evaluation of the adjacent EIR criteria, the SME will place a mark here if they are currently not engaging with the activity and cannot identify where the activity bares significance.
- **Currently In Place:** *coded in green;* through evaluation of the adjacent EIR criteria, the SME will place a mark here if they currently engage with this activity.

As the SME works their way down through each of the EIR criteria within each theme, a cross is placed within each status area.

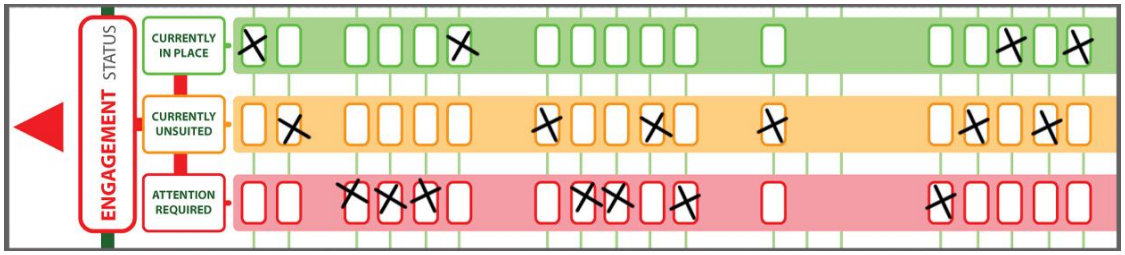


Figure 47: Demonstrating where potential care and consideration needs to be paid within current levels of environmental engagement at a strategic level.

By completion, this will build up an overall snapshot of their current sustainability credibility, see figure 47 above. For example, if all the crosses reside in the **red**, this would indicate that much improvement needs to be made with integrating EIR into current NPD. Furthermore, if the majority of crosses are in the **orange**, this would indicate that further questions need to be asked as to why these activities are not currently relevant to their organisation.

6.7.1 Integration of all Sustainability Key Themes into the NPD Process Mapping Framework for SME Sustainability

Each key theme was subsequently placed in sequence from top down according to the order laid out in section 6.5. This can be seen in figure 48, where the key themes and related actions, benefits, reductions and engagements have been placed directly above the NPD timeline.

For a full overview of the completed mapping process design, see the end of the thesis for a full-sized fold-out version of the map. This map was submitted to the final Delphi method's expert panel for evaluation of the research programme.

For illustrative purposes, only the first two themes of *'Packaging Re-Use Systems'* and '*Transport Efficiencies',* have been used within figure 48, to demonstrate the process of connecting information within the overall mapping process.

These two ***'Key Themes of Best Practice',*** have been mapped into 'Phase 2' and 'Phase 3' of NPD with two coloured lines.

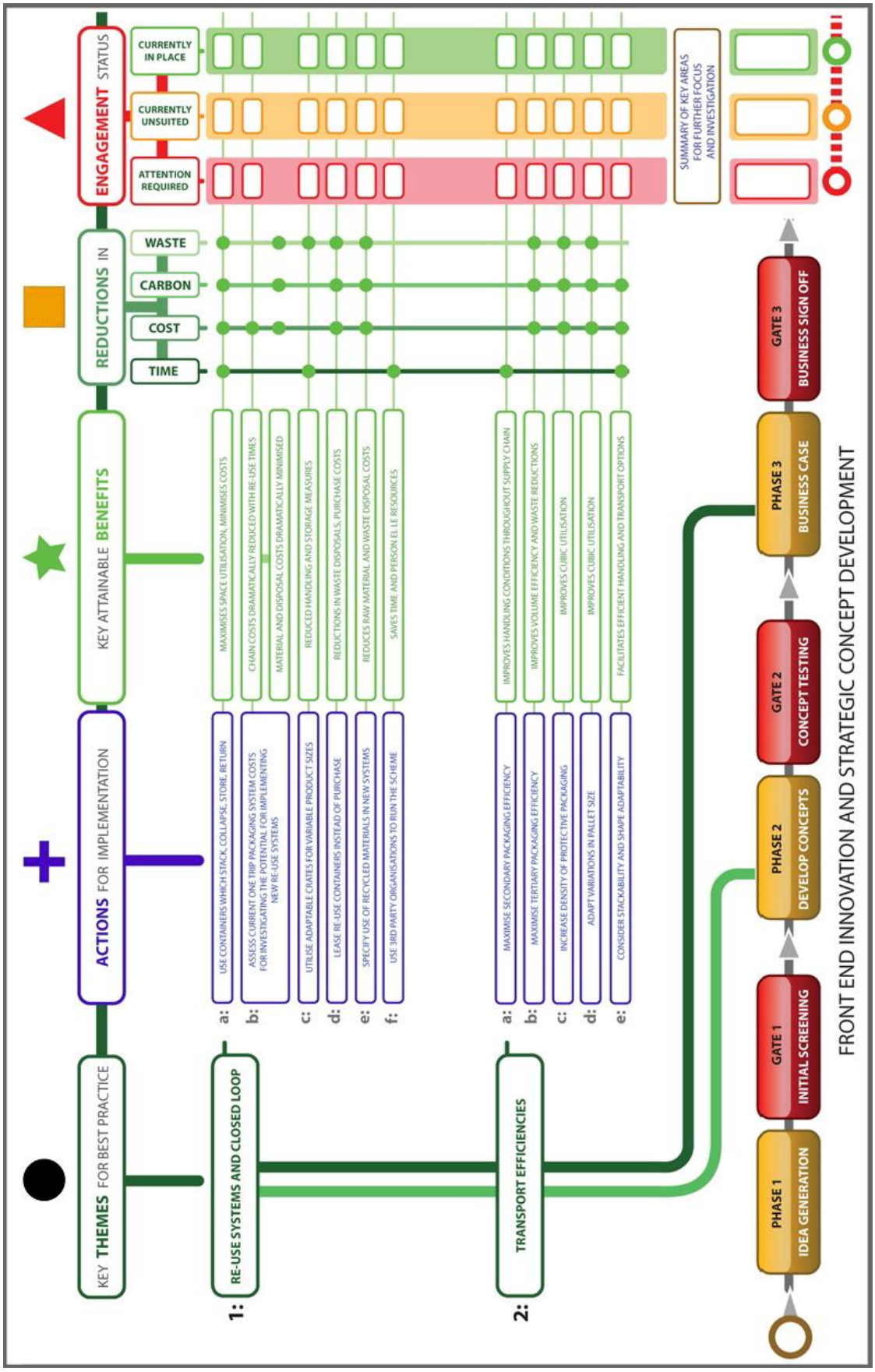


Figure 48: Demonstrating integrating key themes into a generic NPD timeline.

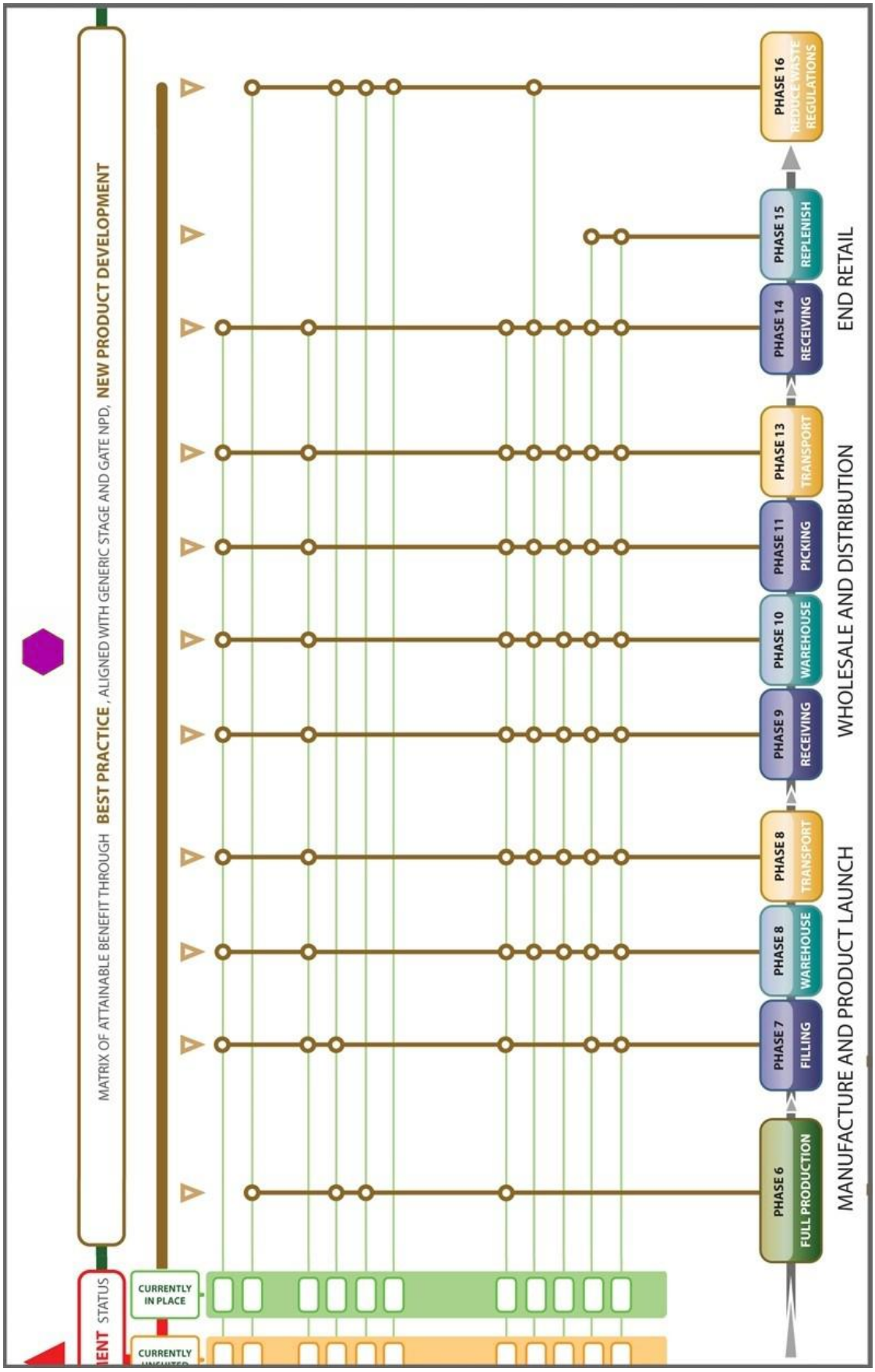


Figure 49: Demonstrating processes of threading sustainability criteria throughout.

Each of these coloured lines relates to a phase of NPD where critical decisions are made in relation to EIR. Initial phases of NPD can dramatically influence overall environmental performance, as early decisions effect the entire life cycle of the product. Therefore, for mapping purposes it was essential to draw attention to EIR within these first early phases of product development. This can be seen in figure 48, where two lines originating from beneath both *'Packaging Re-Use Systems'* and '*Transport Efficiencies'* in **'Key Themes'**, are connected to both Phase 2 and Phase 3 of NPD.

The figure 49 shows the continuation of how each key theme of best practice is aligned through a grid reference system into the later stages of product and packaging logistics. This has been achieved by using a technique similar to the *threading process* used within Chapter 5, which enabled the research programme to visualise industrial questionnaire data over differing subject areas. In this instance, the *threading* has been predefined to align each action and benefit to a corresponding point within a point of subsequent supply chain process. This is to enable the SME user to understand how actions implemented at the beginning of the industrial timeline are unanimously related to those at the end, through a cause and effect relationship.

As an example, this can be observed below within figure 49, where the alphanumeric "A1" is placed on top of two *Actions for Implementation*. As the user of the map works from left to right, they can observe the *Attainable Benefits*, *Reductions* and *Engagement Status* with which they will self assess.

Beneath each of these elements is a line which connects these aspects together. This line continues through the map as the user works to the right, until a point is reached directly above a corresponding activity within NPD where the *Actions for Implementation* (originating from A1), provide benefit. This correlation can be seen

within figure 50 below, where the alphanumeric "A2" is placed upon a point further on within logistics which is directly linked to initial *Actions for Implementation*, (marked with A1), by a series of lines.

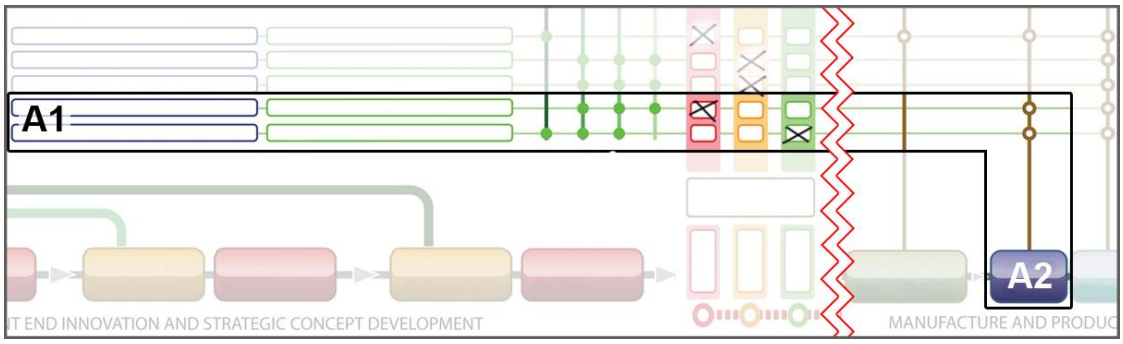


Figure 50: Demonstrating the integration of key themes into a generic NPD timeline.

To highlight the points of intersection where these lines converge, a small circle has been placed for reference. As can be seen above in figure 50, two small circles are placed upon the lines directly above "A2". This tells the user that when working along the narrative from left to right within the process map, when this point is reached, the area directly below is related to the actions and benefits, within each key theme.

This method works well in both directions. The user can pick a specific point within the final stages of NPD logistics and trace the line in reverse, to observe the numerous benefits which can be obtained for that stage in particular from the preceding EIR key themes. This then provides the SME with a tool which can be used in two directions:

1. to identify how many EIR benefits can be drawn against any specific point in NPD process, for quick reference,

2. to use the tool as a formal investigation from the start of the industrial timeline, to observe where improvements are required within NPD and create an overall snap-shot assessment of EIR engagements.

6.7.2 Step-by-Step Walk-Through of Process Mapping use

The following steps explain the narrative which SMEs will engage with the process mapping framework for EIR best practice. The map encourages a step-by-step interaction, and when followed, will guide the user through the embedded areas of EIR activity for improved long term sustainable NPD. Completing this process correctly will explain to the user the types of sustainability elements which can be included within NPD, the actions, benefits and reductions, with the opportunity to self assess against the criteria. This will provide the user with an overall snapshot of current EIR credibility within current practices, which can be considered before moving forwards into further NPD activities.

Step 1: NPD Gate Assessment Criteria.

The SME user begins by identifying similarities between their own NPD process and assessment criteria, against the generic instructions embedded within the first phases of the process mapping tool, shown below in figure 51.

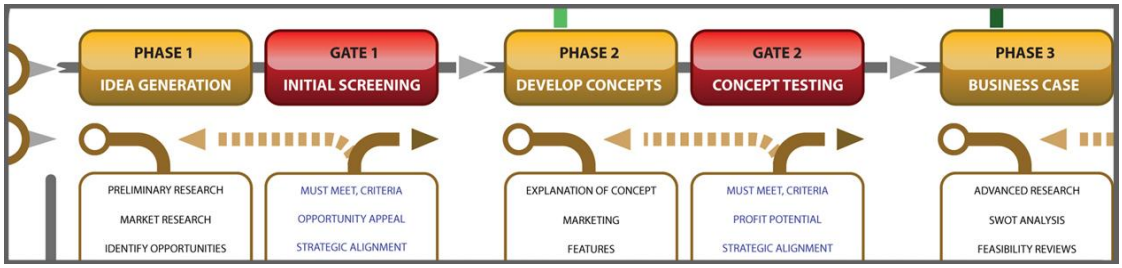


Figure 51: Showing primary engagement with the mapping process and Phases.

The tool at this stage will help to demonstrate the generic considerations within each phase of product development to those with less understanding, and create association for those with a higher level of proficiency.

As the user begins to work through the criteria for each phase of their NPD, they can observe the criteria for each Gate assessment, and begin to consider which of them are priorities for checking project progress. As the user moves on to Phase 2 and Phase 3, the process mapping tool prompts the user to investigate potential EIR key themes, which can enhance the triple bottom-line performance of the organisation.

Step 2: Embedded Sustainability Key Themes and Associated Values.

Once prompted within Phase 1 and Phase 2 of NPD, the user is drawn up to the first in a descending line of six key themes for EIR best practice. The six key themes cover a broad range of activities which will provide material, manufacturing and logistics efficiencies, resulting in numerous strategic and environmental improvements throughout product and packaging developments within NPD.

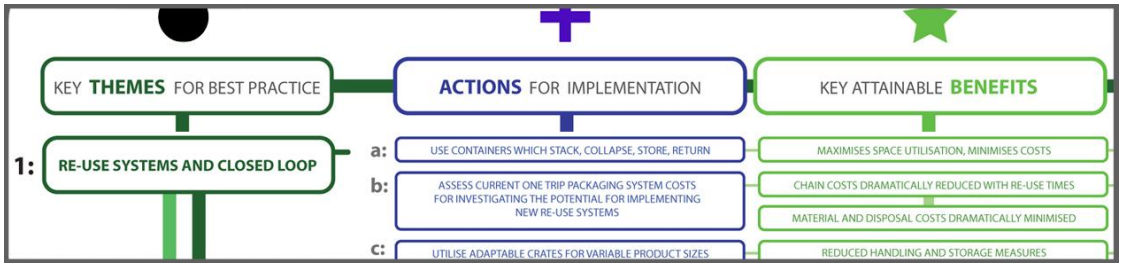


Figure 52: Showing Key Themes, actions and benefits sections of the process map.

These six key themes for best practice are placed in chronological order beginning with simple tasks which can be performed in the house by those with less ability, and concluding with high order operations such as supply-chain partnerships. The intention of the six key themes is to broaden the knowledge base of the SME user within common environmental areas, which they can begin to associate themselves with once an incentive has been realised through engagement with the framework.

In order to provide this incentive, the process mapping tool draws the user across to a number of actions, shown in figure 52, which independently, or collectively, enable the implementation of the key theme in question. The reason for providing more than one action for each key theme is to communicate the various ways in which activities can be engaged with which provide efficiency in one key area. It may be that the SME user is interested in a particular area, but may only find one or two actions feasible. This therefore serves to provide options for the SME user of the tool, while demonstrating an educational process which works on the principle of providing headed, and sub-headed sets of information.

To enhance incentive for the SME user to invest further time in relation to EIR improvements, the process map must provide illustrated benefits adjoined to each action, shown also in figure 52. The SME can use the benefits section to identify where significant improvements can be made within their organisation. This area is essential, as it is common for organisations both large and small to fail to see the benefits to engaging with more sustainable best practices.

Step 3: Specific Snap-Shot Assessment and Contextualising Improvements.

To further enhance the potential rewards for placing a higher priority within environmental improvements, the process mapping tool provides a quick indication of reductions which each action provides. This can seen below in figure 53 on the left where the SME user can gauge which activity will give them the greatest rate of return across a broad range of subject areas, crucial to NPD streamlining.

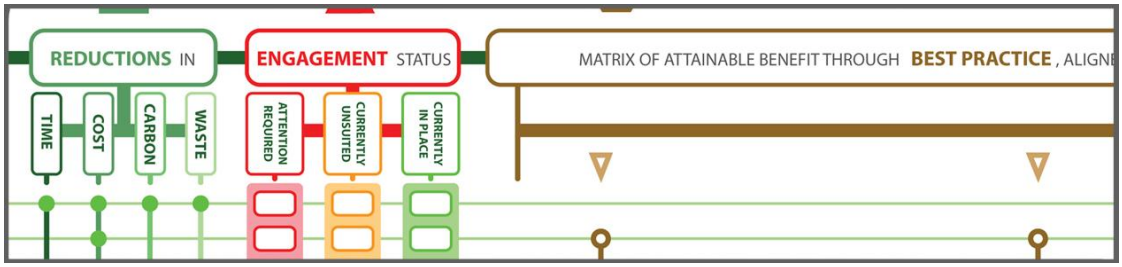


Figure 53: Overall reductions on offer, from Actions, prior to informal assessment.

In order for the SME user to observe their eligibility for these potential reductions, they are then prompted by the process mapping tool to engage with an informal assessment of their current practices, in relation to the actions required to implement each key scene of best practice. For example: as can be seen previously in figure 52, the first *action* is in regards to *packaging re-use* implementation, labelled as "1a". This indicates usage of containers which stack, collapse, store and are returnable.

A simple evaluation is then required to identify if this *action* within the company is either: **currently in place**; **currently unsuitable**; or, **unimplemented**, and therefore ***requiring attention***.

The activity of encouraging the user to work with the map as a point of reference to assess the organisation is a further step in the right direction to changing behaviour towards EIR. This encourages the user to begin taking responsibility for, and understanding the process of, engaging with their environmental managements. This would be opposed to using an instruction manual which is text heavy, laborious and un-engaging for the less informed who see little incentive to engage.

Step 4: Tracing Cause and Effect Relationships of Sustainable Improvements.

For further contextualisation, the process mapping tool guides the SME user from the point of each self-assessment, to a corresponding location further within the logistics

system of NPD. This enables the SME user to understand where, if implemented, the benefits of the predefined actions will relate to processes further on within the industrial timeline.

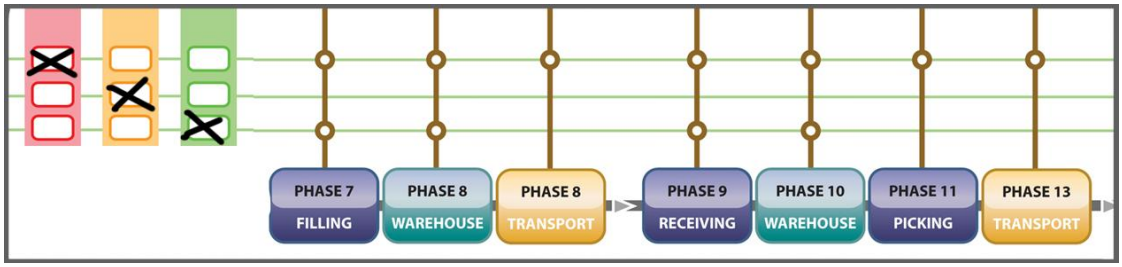


Figure 54: Connectivity between areas of assessment and logistics operations.

This begins to educate the SME user in relation to the longevity of decisions which are made within the early phases of NPD, and their subsequent affect much later in the timeline process. This can be seen above in figure 54.

The threading technique which connects each assessment to a further point in the NPD process enables the SME to work in both directions if desired. This stage is purely for contextualisation to enable the SME user to begin to grasp how decisions early on within NPD can have such far-reaching consequences, and also offer potential improvements when considered.

Step 5: Assessment Summary for Further Action, Focus and Investigation.

To enable the SME user to capture a snapshot of their interaction with the process mapping tool and their environmental credibility, an area is provided to jot down results drawn from the map, post assessment. As the user works through the process mapping tool and self evaluates against each potential area for improvement, the SME is prompted to list the areas which are deemed most important for further investigation.

It may be unfeasible for the organisation to take on board every element which is included within the map, but it may be more feasible to choose a small number of areas for further discussion.

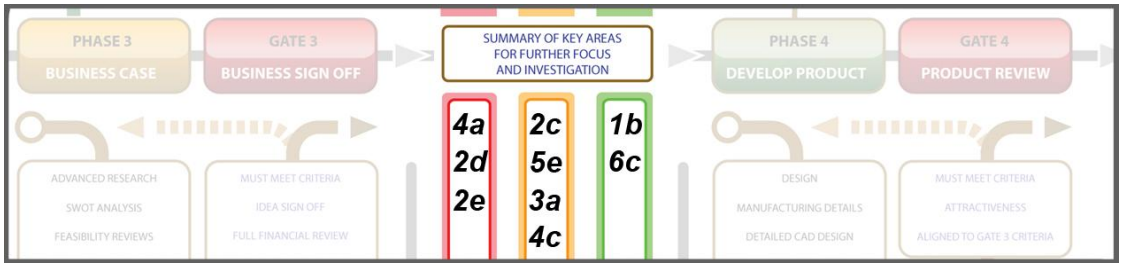


Figure 55: Defining key areas with which to take forwards for further consideration.

This can be seen above in figure 55 where some of the selected actions have been listed, post assessment with their alpha numerical coding within each of the three engagement status boxes.

It matters not that the assessment indicates areas which are: ***currently unsuitable*** or ***attention required,*** as the SME may wish to challenge these areas alongside those which have been assessed to be, ***currently in place.*** The previous assessment activity simply provides the opportunity for the SME to see where they currently stand and to begin to choose the points of investigation with which they would like to make future improvements.

This area has been placed directly in between Phase 3 and Phase 4 of the generic NPD timeline. The reasons for this are twofold. The first is that as NPD moves into Phase 4, a much higher level of resources are dedicated to the project. This comes with the commitment that decisions made within the early phases of development are satisfactory and as such much higher investments are then put into place. Making major changes following on from Phase 4 may not be practical to the organisation, and assessment criteria will mainly focus around the *delivery* of a product idea, rather than the *choosing* of which idea to pursue.

The second reason is that the majority of environmental impacts caused from the products life cycle are initiated within the early stages of NPD. Therefore, it makes sense to place the overall assessment criteria from the process mapping tool at a stage where changes can still be made in light of the information embedded within the map.

Evaluating all criteria from the process map against company strategic objectives early on within NPD will enable the SME organisation to build a more environmentally credible product scenario, before committing to full development in Phase 4.

Step 6: Strategy for Essential Improvements, Defined Through Evaluation.

The final stage requires the user to formally create an action plan for each of the areas defined for improvement. The process mapping tool in regards to this, prompts the user to record information within a custom strategy section at the end of the map on the far right-hand side. A section of this can be seen in figure 56 below.

Figure 56: Showing a section of the custom strategy area, defining improvements.

Each area for further consideration is required to be placed within this custom strategy section of the map. This section therefore includes a: *review date* with which the evaluation took place and areas of concern which were defined as a result of this activity; an area to input *actionable steps* in relation to gaining a further understanding of / implementation of, or collaboration in regards to the area under question; and a *date for completion* and or *completed by*, to keep track of progress.

Results and conclusions from further formal investigations can additionally be placed within the *actions* section of the custom strategy so as to inform future evaluations with the process mapping tool, as to progress and decisions made in chronological order. This section of the process mapping tool is essential as it gives the SME user a tangible result to take forwards from the process mapping activity. It is this custom strategy which will enable the SME user to begin making investigations, and or discussions in relation to the areas with which they wish to pursue.

The overriding benefit here is that the strategies which are defined through this process will reflect those which the SME comprehends the value of and sees a benefit within, from prior engagement with the process mapping tool. The process mapping tool to this effect has enabled the SME to engage with a variety of impact reductive areas while defining their value and relevance to the organisation. This therefore reflects the ability of the SME, providing opportunity change behaviour towards sustainable product development in line with strategic objectives and current capacity for change.

6.7.3 Visual Coding for SME First-Time Use

So as to provide the SME first-time user with instruction for the process mapping tool, step-by-step guidelines have been included. These instructions explain in brief, what each of the main process mapping activities require from the user, relayed in chronological order, for when using the map. These activities are those which have previously been laid out in section 6.7.2, but here they have been summarised to provide useful prompts for when engaging with the process mapping framework.

Instructions for use: the following image in figure 57 shows how these summaries are placed in chronological order. It can be seen below that a duplication of the coding

used to represent each step throughout the mapping process has been assigned, to create symbiosis between the instructions and elements within the process map.

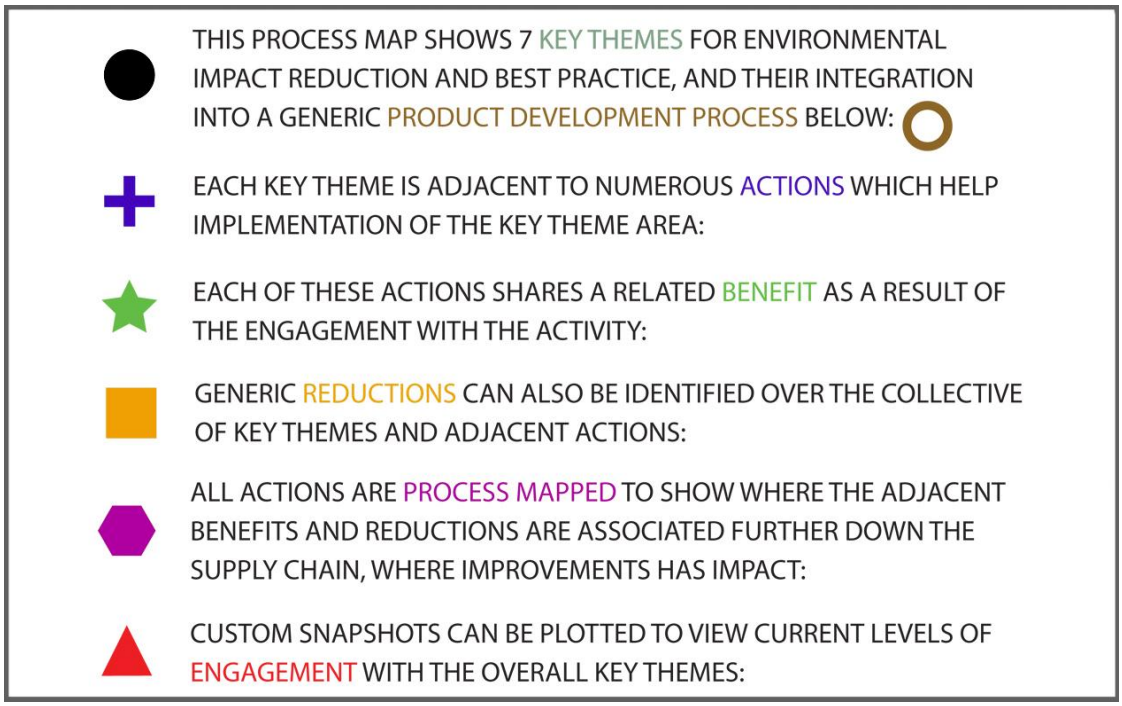


Figure 57: Duplication of the visual coding from the process mapping framework.

For example, each chronological step within the instructions uses the corresponding symbol and colours which have been originally assigned within the map, to build associations within the prompts for the user. This simply helps to reaffirm the visual language used within the system design and builds association between textual instructions and actionable areas within the map. It is important when process mapping and using visual language, to implement consistency with symbolic references used within the work. Keeping symbolic references consistent, avoids ambiguity and confusion by helping to build associations which can be easily recognised by the user.

This method of building associations with shape and colour is a powerful tool, as when used correctly, the process will engage multiple cognitive intelligences used to decipher and comprehend information. For example, some instruction manuals have

coloured tabs which represent different chapters, through repeated use the user will begin to associate a colour with a chapter, improving the power of recall. This method of using symbol and colour may be simple, but from a navigational viewpoint, is highly effective.

The next phase of instruction uses prior associations made with the visual coding, to outline the procedures for extracting value through self evaluation, this can be seen below in figure 58.

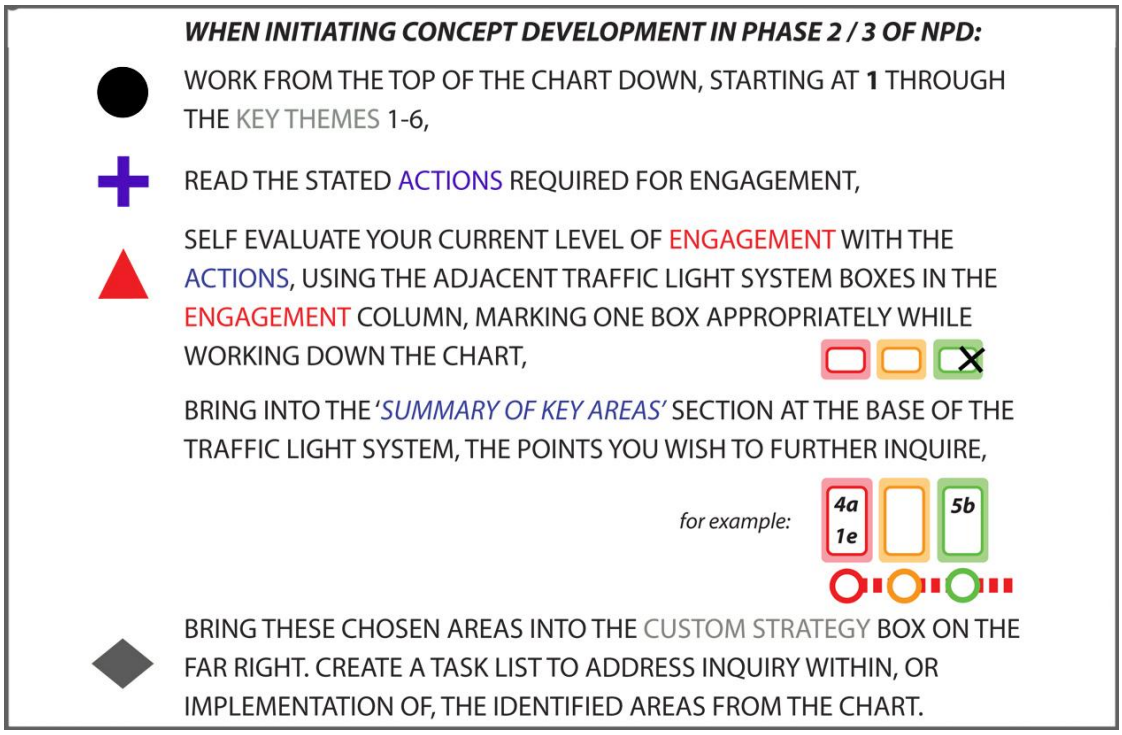


Figure 58: Actions which enable the extraction of sustainability value within NPD.

This section uses the same symbolic references to describe in summary, the actions which must be taken to navigate the map effectively, in line with NPD assessment criteria within Phase 2 and Phase 3 of concept development.

As the process mapping tool is a journey of discovery for the user, this ethos should be reflected in the manner with which the instructions are equally provided. For example, the overall process mapping framework is a prompting method for EIR activity, which uses a visual language to navigate the process mapping system. Therefore, providing

instructions which encourage a process of reflective and reflexive behaviour in order to synthesise use, encourages the required behaviour for process mapping evaluation as a precursor to engagement.

Finally, the instructions for use indicate the separate ways with which the process mapping framework can be implemented, depending upon requirement seen in figure 59.

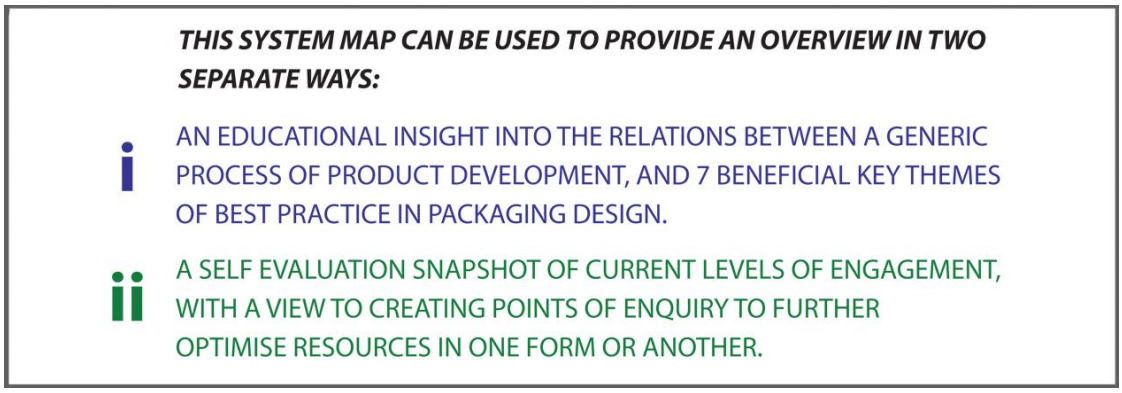


Figure 59: Showing the variance of use, depending on the level of invested interest.

The intention of presenting the two approaches for using the map within the initial instructions is to show the breadth of possibility for engagement. This is to illustrate that investments with the process mapping tool need not be time-consuming or resource intensive, if so required.

6.8 Chapter Summary

This chapter has subsequently addressed the required improvements in process mapping procedure, which were defined through critique of the process mapping tool used to evaluate the industrial questionnaire in Chapter 5. Revisions were required not only in relation to user engagement, but also in relation to the integration of EIR value which the SME user will seek to obtain through use.

Improvements in relation to user engagement focused purely on the narrative of operation and the sequence of events within NPD. This has resulted in building a generic NPD timeline which will provide association for those with more understanding, and educate those with less as to the steps required within the NPD activity. As part of this generic timeline, stage and gate criteria have additionally been implemented to prompt the user to begin considering EIR aspects as part of their standardised assessment strategies.

More focus has been applied to encouraging this assessment within the early phases of NPD rather than the later. Encouraging these assessments within the early phase of NPD can provide cost and process optimisations before heavy resources are committed to further product development. Additionally, making sustainable improvements within these early phases will vastly reduce impacts upon the environment from the total life-cycle of a packaged product, as part the improved concept development process.

Following on from this, the original EIR key themes used to inform the industrial questionnaire were investigated in greater detail. This helped to refine and justify which essential factors of concern derived through industrial questionnaire analysis, which could be grouped into singular themes for mapping use.

A table was constructed which provided visual indications towards which sustainability key themes addressed the greatest number of factors defined from the industrial questionnaire. Collectively, this enabled a refinement process which provided a total of six essential key themes to be included within the final process map. Research publications were again used to locate the most appropriate placing of these themes within NPD timeline, to highlight where implementation of each key theme creates positive impact further along the industrial timeline.

In order to demonstrate an incentive for engaging with each key theme within the framework, further research was conducted to provide the appropriate actions for implementation and resulting benefits, within each key theme of EIR best practice. This enables the SME to be able to observe the steps with which must be taken to engage and the likelihood of return which they can expect from this endeavour.

Additionally, visual indications have been included which enable the SME user to observe potential reductions within the areas of: time, cost, carbon, waste, for each of the sustainability actions and benefits implemented as part of each key theme.

The current redesign of the process map now works as a prompting tool, which encourages the user to perform a self evaluation against the embedded criteria. This therefore enables the SME user to compose a contemporary snapshot of current proficiency, within each assessable area of EIR. Subsequently, when each area has been evaluated the mapping process provides the user with a clear indication of where improvements are required, in parallel with the potential benefits which can be accrued through rectification. The intention of this is to improve the behaviour of the SME in regards to self-evaluation of environmental performance and communicate incentives.

In order to record activity from process mapping use, a custom strategy section has been provided at the end to enable the SME user to structure an action plan in regards to the areas defined to be of importance. This chapter has additionally addressed the visual language and communication of the mapping procedure, with walk through steps and instructions.

To conclude, the process map enables the user to work forwards or backwards within the industrial timeline, to either:

- quickly assess and formulate areas for improvement prompted from any given point within the NPD process or,

- use the process mapping tool as educational method, which formulates self-assessment within the early phases of NPD concept development to encourage long-term sustainability and resource efficiency.

The final design of the process mapping tool now presents a visual method for engaging with sustainable NPD EIR improvements. Through mapping use, these improvements are prompted to encourage the user to self evaluate, against the set criteria which has been defined throughout the former research activity, in line with Delphi research method.

The next Chapter 7 will focus on the results obtained from the expert panel, in testing the principal of process mapping EIR in regards to NPD practice within industry.

Chapter 7 will discuss the choice of the expert panel used for the evaluation and their relevance to this essential stage of the project. It will additionally discuss the method used to perform the evaluation, and the subsequent data which was obtained as a result.

7: DATA ANALYSIS

7.1 Introduction

The previous chapter addressed the steps taken with the design of a process mapping tool for SME EIR activity. Embedded within the process mapping tool is a generic NPD timeline, which visually explains the steps and procedures within each phase. Generic NPD has been interspersed with evaluation gates which prompt the SME user to reflect upon project criteria and EIR criteria within the map. The importance of this tool resides in encouraging users to self evaluate to prompt further EIR activity. Further incentive to engage is achieved through the demonstration of potential benefits and their validity / steps to implementation against existing NPD processes.

This chapter will cover the evaluation by the Delphi method's expert panel and the approach taken to obtain data in regards to:

- The benefit of using this approach to process mapping is to enable engagement with and communication of complex EIR factors,
- How this process would be perceived by other professionals during first-time use.

This chapter will cover the approach which was taken to review the process mapping tool with the expert panel. This chapter will additionally cover the external panel members and their area of professional expertise in relation to the evaluation procedure. Attention will also be paid towards the format which data was received from the panel and the subsequent analysis from the wider viewpoints of professional consultation.

7.2 Delphi Method for Data Analysis of Process Mapping Procedure

As previously defined within section 3.3.4, the Delphi research method uses a panel of external professionals to provide collective input. The Delphi method has been chosen as a research tool due to its capacity to deal with the difficulties faced when working with a large number of SME companies on a consistent basis. Working with SMEs on a consistent basis is problematic due to the constraints of time and costs being at a premium with SME organisations. This leaves little room for continual engagement with other practices non-essential to the running of the business. Therefore it has been practical to find a group of industrial professionals who can offer a wide range of experience and knowledge on an iterative basis throughout the research programme. The objective will be to obtain the most reliable consensus of opinion by obtaining multiple professional perspectives from respective areas of industry.

The overriding goal of using the Delphi method has been to make the most of expert experience where available. No-one has been invited onto the panel that does not contribute to the research aim of improving SME comprehension of EIR practice within packaging development. Some difficulty was experienced in maintaining continual contact with the entire panel due to the importance of work commitments. The panel will be represented by alpha numerical coding, introduced with anonymised descriptions of their contextual industrial area.

7.2.1 Research and Evaluation Panel Members and areas of Industry

For context, the areas illustrated below will begin furthest from the SME starting at the outer reaches of supply chain logistics, working inwards towards SME manufacturers. Each of these areas represents a key component to the overall EIR practices of SME organisations.

Area A, Trade Association: currently working as the UK association of packaging industries. This area is a unique representative body for companies and organisations in the UK packaging manufacturing sector and its many associated activities. This area actively promotes the economic importance of the industry, the products which are produced, and the considerable benefits which derive from the use of packaging including responsibilities for both the community and the environment.

Participant A1: currently Chief Executive of this UK packaging association, and has worked with packaging for over 30 years in industry, dealing with businesses of all sizes.

Relevance for A: the organisations which are associated with this area range from the largest businesses to the smallest where all facets are dealt with including glass, metal, paper, board and plastics. Additionally, recycling organisations are associated with this area. Considerations voiced from this area offer an industrial perspective for packaged products.

Area B, Research: currently working as an industrial Council which associates itself with environmental research on packaging. This area is a non-profit organisation whose objective is to analyse the environmental and social effects of product packaging. Members of this council deal with raw materials, suppliers, manufacturers and retailers. This represents all main elements for the packaging goods supply chain. Collaborations within this organisation aim to research issues and optimise outputs for packaging to reduce environmental footprints and help consumers live more sustainably.

Participant B1: currently a director of this UK research Council, with over 20 years of experience within environmental sciences, while additionally maintaining the position as a member of the UK government's advisory committee on consumer-products and the environment.

Relevance for B: by nature this area offers a holistic but professional approach to new areas of development within packaging resources. Therefore this area is ideally positioned to voice considerations towards new approaches within environmental systems, such as process mapping for sustainability where product and packaging are associated.

Area C, Regulations: currently working as a regulator for all areas in relation to the quality of, and design of packaging which is placed within the current supply chain. This regulator works with the government and stakeholders to ensure the enforcement of consumer related legislation. Additionally, this regulator can work closely with SME businesses and request technical documentation in relation to the performance of, and the specification of packaging released upon the market.

Participant C1: formerly the divisional manager of the strategic management team, whose responsibility is to ensure all businesses are compliant with statutory legislation. Activities revolve around company inspections, legislative breaches, and providing advice to businesses.

Participant C2: currently a principle officer of the strategic management team, whose responsibility is to ensure all businesses are compliant with statutory legislation. Previous activities aside those of participant C1, have additionally involved

developing process check systems for SME companies to enable the identification of potential packaging improvements.

Relevance for C: this area deal specifically with the essential requirements which packaging must be manufactured, distributed, and disposed of throughout logistics. In regards to maintaining the efficiency of packaging sustainability, this area is the only one which has authoritative power and essentially works with SMEs on the ground level.

Area D, Consultancy: currently working within the area of consultancy for small businesses in regards to the environment and packaging design. These consultants work with SMEs on a range of sustainability factors, to provide advice upon the engagement with packaging creation, through to the end life cycles of wastes and disposals.

Participant D1: currently the managing director of an environmental consultancy. With over 20 years experience in helping small businesses improve their packaging design, waste disposal processes and innovation techniques. In total, working with over 800 companies during this 20 year period, saving a total of over £70 million for clients through improved packaging and resource designs.

Participant D2: currently the creative director of a packaging design agency, with over 25 years experience in brand and branded packaging design. Day-to-day activities involve working with all businesses large and small to develop effective packaging solutions, from the initial origins of design, right through and up to point-of-sale.

Participant D3: currently senior environmental consultant, within the mentor services of a large banking organisation. Day-to-day activities include working as an

environmental management professional, collaborating with SME businesses and on projects to improve regulation compliance performance, identify resource efficiencies / cost savings and improve 'green' credentials of businesses.

Relevance for D: these consultants are independently contracted to work with SME businesses on a broad range of environmental topics. Therefore, this puts them in a unique position to be able to provide first-hand and contemporary experience, in relation to the difficulties with which SME organisations commonly struggle and wish to address when seeking consultancy advice. Additionally, through consultancy, these participants are engaged first-hand with the entire process of developing new packaging solutions, for SME businesses.

Area E, SME Businesses: currently operating as businesses under the division of SME classification, for the manufacturing of both food product items, and electronic product items for the UK market.

Participant E1: currently the managing director of an automation research and development facility, which provides electronic products to the manufacturing industry, to replace personnel with automated alternatives. Packaging within this industry essentially revolves around tertiary packaging, as the product is intended for direct delivery to the manufacturing environment rather than, for consumer purchase.

Participant E2: currently a managing director of a multi-million pound juice drinks company. Although successful, this organisation works closely with packaging consultants to develop effective packaging solutions to promote the brand of their product.

Relevance for E: these SME businesses are in a prime position to offer their opinion in regards to the difficulties faced through the fruition of packaging development and engagement with environmental credentials. They typically represent those who are pressed for time and potentially alienated from larger supply chain logistics, and, or, the critical eye of regulators due to their size.

7.3 The approach to Panel Evaluation for the Process Mapping Tool

As the Delphi research process uses expert opinion via method of questionnaire, a postal package was put together to send out to the expert panel for evaluation. This contained:

1. The final process map tool for prompting SME consideration of sustainability, in line with the generic NPD process.
2. A set of questions, posed in relation to critiquing the process mapping tool to validate and justify if the research and development aim had been achieved.
3. A covering letter, outlining what was required from the expert panel, in terms of their input through the methods provided.

The overall objective was to obtain a response from the expert panel which validates whether:

1. There was significant evidence of benefits in the process of engaging visually with complex environmental data to assist with comprehension
2. Engagement with the process mapping tool would be perceived as being of benefit by others involved in product development, presently unfamiliar with it.

To set the context of the evaluation for the expert panel, the covering letter set the scene for each panel member in the following manner:

"I have sent to you a copy of the final process map which I have been working on for the Ph.D, it aims to bring together the benefits of sustainable activity and merge them into new product development visually. Hopefully this will aim to help SME companies create a 'snapshot' of their current engagement by visualising opportunity for further investigation, a prompting tool for helping further engagement with impact reduction activity."

Requirements from each panel member were described in the following manner:

"What I require from your help is:

- *Please work through the map, as if you were considering new product / packaging and looking for potential improvements and reductions. (The map also contains instructions for use down the side, for filling out the traffic light boxes and strategy section).*
- *There is also, on the reverse of this letter, a six question feedback form, which will be essential for us to refine the use and value of the map from your experience. If you could please fill this out after use to capture your thoughts.*
- *I have included an envelope and stamps for the return postage when complete, if you can please return these when convenient to you.*

I am hoping we can use your feedback to refine the method in practice and contribute to further research within this area. Thank you in advance for taking the time to look through this, I understand time is tight and I am very grateful to you."

This covering letter served as a precursor to mapping use to set the scene in the same context as an SME organisation unfamiliar with the operation of the process mapping tool prior use.

7.3.1 Process Mapping of Impact Reduction Feedback Questionnaire

The following information will illustrate each question posed within the feedback questionnaire, the origins for the question and the requirements.

1. ***In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?***

Research has suggested that SME organisations fail to be able to see the value embedded within sustainable and EIR activities, through the perception that such activities are waste of time and resource. The process mapping tool aims to address this issue by communicating the value of EIR through a process of self-assessment, where action and benefit is illustrated. Evidence here would show that the value of process mapping sustainability as a visual method holds merit in enabling businesses to interact with complex environmental data.

2. ***In what ways has this process mapping tool informed your understanding of:***

    a. *Assessing and NPD process in terms of sustainability*

    b. *The development of your personal objectives towards potential new practices*

This question sought to address how well the panel evaluations have been enabled to integrate the key themes of EIR criteria, against the corresponding points within NPD as an educational process. Additionally this question seeks to define how well this interaction has enabled the panel to strategically choose areas for further investigation. Evidence here would show that the process mapping tool enables EIR to be considered as part of the wider NPD system.

3. ***Where has the map demonstrated within your company the potential for:***

    a. *An environmental impact reduction within NPD*

    b. *Cost reduction within NPD*

This question sought to address where the process mapping tool has created impact through evaluation. Essentially, two key considerations for reductions are those of environmental and financial. Evidence here would show that the process mapping tool has provided a tangible output through effective use and has provided validation for reductions within NPD.

4. ***How do you see this mapping process being used to develop competitive advantage?***

This question was left open to allow the panel members to voice their professional opinion in relation to where they saw a good fit for this process mapping tool within industry from their respective professional areas. Evidence here sought not only to validate whether the process mapping tool addressed issues identified within the research, but also contributed to areas for future research.

5. ***What benefits did you find as a result of this review being visual, rather than purely textual?***

This question sought to address the hypothesis that working visually with complex environmental information can simplify the learning process and could enhance user engagement with the data. Evidence here sought to validate whether the process mapping tool can facilitate EIR through a novel method while using a visual language.

6. ***In carrying out this review, did you find any opportunities for improvement of the process mapping tool?***

This question was left open to allow the panel members to voice their professional opinion in relation to where further research opportunities could be identified.

The following question was posed only to panel member participants C:

7. ***In what ways could you see this method being used as a common template between the regulator organisations and the SMEs, to disseminate and digest requirements and obligations?***

This question was left open to see if C participants would identify further research opportunities in the method. This was essentially because environmental sustainability data is disseminated by the regulators. Therefore, further research opportunities could provide an opportunity to develop a new form of communication where accessibility or understanding is lacking.

7.4 Analysis of Data from Panel Evaluation Feedback

It is essential to note that the most important panel feedback has been from those who completed the questionnaire in conjunction with a critical review of the map. However, it needs to be acknowledged that due to project / time constraints on industry none of the evaluation panel was able to use the mapping tool on active industrial processes.

Other than the SME organisations, this is largely a consequence of using a broader base of differing industrial sectors as an evaluation panel, in order to gain multiple perspectives. As a result, the orientation towards working practices with panel members (A-D) other than the SMEs (E), are largely concerned with the context of the process maps functionality 'for others'. This reflects the nature of the work panel members A-D engage with, which originates from a consultation and regulatory perspective, where working for and advising to others is their core discipline.

This is essential as it gives the evaluation process a wider perspective towards the appropriateness in mapping use for SMEs, which panel members A-D work in conjunction. Where responses to the questionnaire were not consistently obtained due to project / time constraints on industry, further required feedback was attained through email format or direct phone conversations which were subsequently transcribed (see appendix 1.11).

Question 1:

In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?

Answers from the expert panel in relation to how the process mapping tool can 'facilitate' understanding for SMEs, have been offered from a visual systems design perspective and an educational perspective.

From a visual systems design perspective: all panel members unanimously voiced that the visual layout creates a systematic approach, which enables engagement within an otherwise currently long and complex supply chain. Panel members across-the-board voiced that the current format provided good understanding of the process with logical steps for the user to follow, in order to assist with the "what do I do next" type of questions. For example, SME participant E2 explained that the logical steps within the current process map are good for advising SMEs, through the laying out of commonsense principles which cover all elements. Packaging consultant D2 explained that for client consultation this tool is excellent, as the process mapping format avoids the need for complex jargon, which can be difficult for the average business owner to digest.

From an educational perspective: all panel members unanimously voiced that the benefit lay in the presentation of common-sense principles, which are informative and cover all elements to integrate green issues into NPD. Regulations participant C2 said that the process map assists with the thought process through the approach of 'self challenge' to pose the right questions; while additionally prompting and showing value, continuing that currently there is a need for this in industry. In line with this, Trade association participant A1 also said that all elements inside the map are important and comprehensive to industry at this current time. Additionally, Research

council participant B1 said that the informative nature of the process map enables all elements to be brought together, in comparison to using disparate literature droves of environmental data.

Question 2:

In what ways has this process mapping tool informed your understanding of:

a. Assessing NPD process in terms of sustainability

Due to the external panel responding to question one from not only a visual systems design perspective, but also from an educational perspective, the majority of the panel's response to question 2 was essentially a duplication of question 1, or comments such as "same as above". Packaging and environmental consultants D1 and D3 agreed that the process mapping tool helps to communicate complexity and enables the definition of steps to approach implementing green activities as a creative role. Although SME company E1 shared the opinion that the structure of the tool may be too rigid for some SMEs, this therefore opens up the opportunity to allow for degrees of customisation in future mapping versions.

In what ways has this process mapping tool informed your understanding of:

b. The development of your personal objectives towards potential new practices

Responses to this question were minimal from the external panel, due to the panel members using the process mapping tool for critical reference, rather than a live project overview. Regulations participant C2 did voice that the development of

objectives are plausible because the process mapping tool assists with the recognition of benefit to changing organisational behaviour. Although environmental consultant D3 raised a concern that the development of personal objectives, encouraged by the map, really do depend on pressure being driven within immediate supply chains, which may impact upon the SME.

Question 3:

Where has the map demonstrated within your company the potential for:

a. Environmental impact reduction within NPD

Due to none of the panel members using the process mapping tool on a live project, there was no consistent and quantifiable response to this first part of question 3.

Where has the map demonstrated within your company the potential for:

b. Cost reduction within NPD

For the same reasons mentioned above, there was no consistent and quantifiable response to this second part of question 3. Although, Packaging consultant D1 voiced that because the process does assist with asking the right questions at the design phase, impact reduction is plausible throughout the process and therefore; any changes within the process are financially viable as green design should always save money. Additionally, environmental consultant D3 explained that even though cost savings are implied within the process map, in its current format it would be difficult to quantify exactly how much. Therefore, in further development, a mechanism needs to be embedded within the map to provide a numeric value of cost savings.

Question 4:

How do you see this mapping process being used to develop competitive advantage?

Due to time constraints and no live project, SME panel members E1-E2 did not respond to this question. The majority of other panel members voiced that the development of competitive advantage in their opinion, would mostly revolve around the reductions of cost for the SME. Packaging consultants D1 and D2 responded that competitive advantage would be gained via addressing better product features through more visible commitment using the process map, which will essentially help to qualify on packaging environmental credentials. Trade Association participant A1 also contributed that the process mapping tool helped improve communication, by asking more informative questions with suppliers.

Further development was again suggested by environmental consultant D3 in that competitive advantage would be easier to gain if future iterations of development include costing analysis models. Additionally, benchmarks from similar sectors would be of benefit to enable performance comparison for the SME with the process mapping tool.

Question 5:

What benefits did you find as a result of this review being visual, rather than purely textual?

Panel members were unanimous that although the map looked complex at the outset, the process mapping procedure provides a clear, consistent and concise approach to engaging with all data included. Both SME panel members voiced that the process mapping layout works well to logically cover all elements of possible factors in

relation to sustainable NPD. Regulations consultant C2 explained that the current mapping method assists with information recall at various levels of engagement throughout the process, through the prompting approach which helps to challenge SMEs. Packaging consultant D2 responded that the tool is good for SME business to follow at the genesis of the product idea, even if only one or two actions are taken, it's a start for SMEs.

Question 6:

In carrying out this review, did you find any opportunities for improvement of the process mapping tool?

All panel members were unanimous that the information within the process mapping tool at the outset looked overwhelming, but once engaged with the simplicity of the approach became obvious. Potential improvements, from the majority of panel members indicate the need for potential cost savings with data to quantify the exact financial benefit. Environmental consultant D3 commented that the tool at its current stage focuses largely on environmental performance, rather than the financial elements of sustainability, nevertheless the narrative to engage in its current format is clear and straightforward.

Further opportunities for improvement from Packaging consultant D1 suggest that working examples would be good for the SME user to demonstrate initial use, whereas Trade Association participant A1 said that the running order of themes within the map could be reconsidered, where only EIR themes in relation to ideation are considered at the initial phases, and later elements of EIR are integrated much further down.

Question 7:

In what ways could you see this method being used as a common template between the regulator organisations and the SMEs, to disseminate and digests requirements and obligations?

This question was asked only to the participants in relation to packaging regulations. Response from participant C2 was that a common template and checklist could certainly assist in any dialogue for SMEs. An online version of the process mapping tool would work well to inform local SME organisations in relation to online specific issues embedded within the map. Further engagement would then enable the SME to contact their local regulations organisation with more informative questions to build discussions with the mapping process, empowering the SME to self educate by challenging behaviour.

7.5 Chapter Summary

This chapter has recapped on using the Delphi research method through panel evaluation and its appropriateness to the research project to provide assessment of the process mapping tool from professional practice experience. Evaluation was achieved through the construction of a final industrial questionnaire which was sent out to the evaluation panel with the accompaniment of a blank process mapping tool for reference, and covering letter with instructions for the panel. Due to time constraints, industrial priorities, and supply chain perspectives within the panel, the panel members only used the process mapping tool for critical reference in order to fill out the industrial questionnaire, as oppose to running a live project through the map. Where responses from the panel varied in terms of the format which data was returned in, phone conversations were made and transcribed to fill in the gaps in required data.

Overall the responses to the process map evaluation from external panel members were positive. They demonstrated that in terms of visual communication, the current method enables a systematic logical and informative approach to engaging with complex environmental data, while comprehensively integrating each factor into generic NPD. Specific comments revolved around the tool enabling SME organisations to pose the right questions through self challenge and prompting behaviour change as a result of use. Therefore in its current phase of development, the tool provides a comprehensible and stepped approach to implementing green EIR activities as a creative role, in what would otherwise be a complex and laborious supply chain system.

Panel members additionally felt that the process mapping tool initially appeared overwhelming, but when they 'took the plunge', the simplicity of the process was obvious. This raised the potential for improvement in the customisation of the process mapping tool to enable SME users to pick and choose the areas they wish to work with from the outset. Additionally, further support could be provided through the inclusion of potential examples to help first-time users' work through the process. Further opportunities for improvements were suggested mostly within the areas of quantifying actual cost savings from full implementation within industry processes.

In its current state of development the process mapping tool focuses largely on environmental performance, rather than the financial elements of EIR. Consultants would like to see the process mapping tool demonstrate some area of customisation to enable the reordering of EIR prompts in a running order which suits the SME. This should be backed up with a further method of obtaining a solid and quantifiable cost saving from each of the EIR processes demonstrated, and potential industrial benchmarks to work from.

This evaluation has shown that the current process mapping tool works well to deliver the critical information which has been defined through the research process, in a manner which is comprehensible to SMEs needing to self-educate. Through further refinements and improvements, this method demonstrates wide potential for further research and implementation within product producing SMEs to communicate EIR opportunities.

The next chapter will focus on lessons learned throughout this programme of research. This will highlight the areas which could have been tackled differently to provide a more effective result. Therefore, critical limitations will be raised in light of working with industrial practitioners and SMEs, when trying to obtain broad and consistent industrial data.

8: DISCUSSION

8.1 Introduction

The previous chapter focused on the analysis of the final process mapping tool which was sent out to the expert panel for evaluation as part of the Delphi research method. This chapter focuses on points within the research which have not been discussed previously. These points will include the following three areas:

1. *Limitations of the research programme:* points within the research which negatively impacted this study. These have originated from areas outside of the control of the research programme due to the context of the work, and areas for improvement as a result of learning throughout the research programme. Limitations within the research programme will be grouped into the following three areas:

    a. Limitations of working with product producing SME businesses.

    b. Limitations of data gathering within this programme of research.

    c. Limitations of working with an external panel for evaluation through the Delphi method.

    d. Limitations of investigating within this PhD research timeframe.

2. *Alternative approaches in hindsight:* in light of the aforementioned limitations, this section will discuss the potential areas for improvement which could be implemented if the study of this research programme were to be continued, or repeated.

3. *Positive aspects of the research programme:* this will draw attention to the usefulness of the research activity in regards to adding value through mapping.

8.2 Limitations of the Research Programme

Various factors had an impact on the research throughout the duration of the study, not all of which were expected. Those which were expected involved the logistics of working with SME product producing businesses, raised as concerns during the initial literature review. Those which were unexpected involved the practicality of dealing with the industrial survey data, and related problems in achieving consistency when working with an industrial panel; whose work commitments would override their gestures of goodwill made towards the research.

8.2.1 Limitations of working with SME Product Producing Businesses

Due to restrictions in size impacting upon capacity for change SMEs generally tend to struggle with incorporating activities outside of those deemed essential for day-to-day business. Therefore, for SMEs to warrant and justify the additions of time and cost, an obvious benefit and return on investment must be readily apparent. It is this prioritisation which makes gaining the attention and cooperation of the SME community a very real challenge, as their time for discussion and interest is at a premium.

The inherent failure of SMEs to see the importance of environmental best practices contributed to a degree of disadvantage in this research. The initial approach was to send out the industrial questionnaire with a covering letter which indicated the potential benefits of engaging. This highlighted that the intention of the research was to improve sustainable best practice with the intention of providing eventual cost benefit from engagement. The covering letter also addressed that upon request the SME participant would be entitled to the research findings, to be able to improve their

own performances. To increase the likelihood of response, every SME was contacted twice with the survey via post.

In reality, the response rate was much lower than anticipated, around 10% of the SME sector. This may have been largely a consequence of SME businesses not having the time or resources to engage with the industrial questionnaire, which was anticipated due to the concerns raised within the literature review. This may also have been a consequence of the accuracy of the Corporate Researcher database, in providing the correct addresses and named managers within the SMEs.

This has been highlighted because additional responses were returned purely to inform that: the business was no longer functional; the SME size classification was inaccurate; or the named persons' within the organisation were no longer employed or in a position to comment. Additionally, some respondents commented that they were not in a position to disclose what they considered to be private information and therefore would not be able to respond. This demonstrates the unreliable nature of working with online databases. Although proficient in segregating information for the user, online databases are based on the assumption that the content embedded is both up-to-date and accurately informed by the SMEs.

A further potential limitation when contacting the SMEs through an industrial questionnaire was the complexity of information required. Due to the nature of the research being emergent, it was essential to propose broad questioning to be able to filter and extract points for further focus. Of the 10% of SMEs which responded this approach worked well in providing a broader data set, but additionally may have been off-putting to the majority of other SME contacts. Using 20 questions could have been too time-consuming for the SME, whereas using a 10 question approach may have effectively doubled the response rate due to the reduced complexity. Responses may

have been higher had the industrial questionnaire presented points of discussion which were more specific. This presents a problem when performing emergent research, as the emergent approach requires broad contextual questioning to pinpoint further areas of focus. Additionally, a lack of invested interest may be present from SMEs when responding to industrial questionnaires.

Greater impact from the industrial questionnaire may have been achieved by proposing critical questions which inform the research at critical stages of development. This is due to the realistic likelihood of only gaining a one-time response from SMEs, so maximum value needs to be obtained. This means that an appreciation for the right time to contact SMEs; participant time to respond; and the informative nature of the questioning are vital.

8.2.2 Limitations of Data Gathering Within the Research Programme

Using the postal method for industrial questionnaires provides a more personal touch and can enable the research to be more tangible with the target group. An online database can be convenient to attain postal survey addresses, but the effectiveness of gaining responses against the initial efforts involved, does have its limitations. Online resources can be useful for obtaining company segmentation, contact addresses and personnel details, although they do reply on being kept accurate and up-to-date to be effective.

Collecting the required data for postal surveys proved to be time-consuming and laborious to put into practice. Considerable time was used to categorise potential contacts and then download appropriate company data to extract addresses and named personnel. Just over one month was used to locate all contacts for the research, define them into categories and then create adequate postal questionnaires.

Considerable time was also taken up in creating a second batch of industrial questionnaires used as reminders for those who had not responded. This did initiate some further response, but the total time required from start to finish was just over three months in total. This negatively impacted the momentum of the research for a time and presented a cause for concern with the completion of the research being so dependent on the data from the industrial survey.

Further complications were subsequently presented when working with the broad nature of data returned from the respondent SMEs. Due to the research method being emergent, it was required that the industrial questionnaire covered a wide range of topics. The objective was to enable a refinement towards key areas of current issues within SME EIR, which could be embedded within process mapping designs.

Using a spreadsheet programme like Microsoft Excel to visualise data provided little benefit within this programme of research because of its limited flexibility; providing only singular visual graphs for comparing singular quantities. The nature of this research required that multiple and differing sets of quantities needed to be compared against each other, and results related back to the packaging supply chain system. Excel worked well for giving a simplistic visual indication to a small set of singular values within one graph, but struggled when cross comparing multiple datasets. Therefore, this informed the next phase of development by using the effectiveness of visual process mapping to visualise the quantification of results obtained from the industrial questionnaire. Using a visual method within this phase of the research enabled the data to become more tangible in context of origin, rather than being restricted to standardised bar graphs and pie charts.

8.2.3 Limitations of Working with a Panel Evaluation through the Delphi Research Method.

The overriding limitation throughout this programme of research has been buy-in for all parties and the incentive to correspond for the external panel of experts. The main incentives for correspondence throughout this programme of research have revolved around the nature of goodwill from those who contributed, backed up with an element of personal interest. This has provided a challenge in finding those who are contextually appropriate for the research; those who are able to give input; and those who will continue to do so in line with the emergent Delphi method. Due to variations within the applicability and availability of those contacted during the research, the expert panel has evolved throughout the programme to include those who can be more consistent in terms of response.

Using expert panel members who are excluded from any direct benefit with the research reduces the likelihood of being able to predict consistency in gaining input when and as required. Only through determination and persistent but polite reminders was the required data obtained within each phase of the research. Additionally, as the combination of expert panel members operated independently from each other, gaining valuable input within a fixed timeframe was also unpredictable and at times impractical. This was due solely to the panel's independent workloads and project timeframes taking precedence. This simply meant that more programme time was required to compensate for the ad-hoc nature of responses from the expert panel. Working in this manner made structuring a rigid timeframe somewhat challenging. It also had to be accepted that working within a doctoral programme timeframe limited the opportunities to engage industry in anything more than 'snap-shot' surveys. Any idea of taking an action research approach to improve industry processes through

process mapping reviews was not feasible within the timeframe of this programme of research.

Using the emergent approach to research also presented complications at project initiation when working with the potential industrial panel. Due to the nature of the emergent approach informing the research direction as data became available, this meant that informed discussions within the developmental stages of the research were hard to initiate. Professional experts within industry are typically short of time when it comes to dealing with additional requests for information and short of patience when it comes to dealing with those with a rudimentary level of knowledge. This was experienced when trying to build initial discussions with Envirowise in relation to potential avenues for investigation within sustainability. Similar problems were also encountered when dealing with the Packaging Federation in gaining confirmation of the proposed packaging supply chain systems designs. Correspondence here was terminated due to a lack of basic understanding to inform further discussions.

Although these events confirmed that those without the basic levels of knowledge cannot engage in EIR dialogue effectively (such as SMEs), it also presented a barrier to progress for the research. This meant that the emergent approach of data gathering was essentially restrictive when relying on the input of others to contribute grounding knowledge to inform further discussions. In order for the emergent approach to be effective with the Delphi panel, a competent level of expertise was first required to facilitate useful dialogue.

In relation to the final evaluation of the process mapping tool, difficulty was presented in achieving consistency in the format of response from the expert panel, even though the cover letter clearly indicated requirements. This was largely due to prioritised work commitments overriding the requested research contributions, meaning that responses

became rushed and ad-hock. Additionally there is no regular timeframe synchronisation between panel members who operate in isolation. In order to attain a suitable response from the expert panel considerable time was used up in waiting to obtain a satisfactory result for data collection. This was particularly the case with SME panel members, where obtaining a response was laborious, resulting in responses appearing rushed and incomplete when finally returned.

Inconsistency of form of response from the expert panel may have reflected the initial problems experienced by the SME sector potentially being overwhelmed by the industrial questionnaire. The entirety of the expert panel only used the process mapping tool as reference for answering the questions, although the format of returning the answers differed. This means that although more contextual information was sent to the expert panel to assist evaluation, the quality of the response was potentially reduced due to the burden of the task.

It was also initially understood that due to project and industrial constraints, running a live project through the process mapping tool within this programme research would be unfeasible with the panel. Nevertheless, it had still been expected that some degree of interaction involving the map around typical project conditions would still have taken place with some of the panel members. Due to the questionnaire taking priority as a key objective for evaluation, and the additional effort required to engage with the map, efforts were only invested in the questionnaire.

8.3 Alternative Approaches in Hindsight

On reflection the majority of the problems which were encountered during this programme of research, originated from the chosen methods of using an emergent approach to data collection, subsequently interspersed with the Delphi method's expert

panel evaluations. These methods were chosen as they were the most appropriate for engaging with the subject area of SME EIR, where significant definition still needed to be obtained to inform the process mapping procedure. The difficulty with using the emergent approach meant that engaging in professional discussions with industry was limited within the initial stages of the research. This was due to the lack of contextual knowledge that was available other than access through literature.

8.3.1 Case Study Research as Opposed to Emergent Research

An alternative would have been to conduct a number of observational case studies with local SME manufacturing businesses to record the day-to-day practices towards environmental best practice. Initial case study observations could have been informed by the literature review in providing a small set of criteria to check against SME practices. For example; knowledge of regulation procedures and awareness of potential improvements / knowledge of attainable benefits from environmental best practices.

Running a number of localised case studies within the initial stages of the research programme would have potentially provided a number of indicators of required EIR improvements. These indicators could then have been used to inform a further set of questions. These questions could have been returned to the SME correspondents to help refine the focus of the research and key points for process mapping procedure.

Using a case study approach could also have provided a more consistent and predictable level of engagement with the SME participants. This angle of approach may have received a greater buy-in with invested interest from the SMEs enabling a more reliable resource of data, with the addition of potential evaluators for the final design. Working alongside SMEs through a case study approach may have provided

the opportunity to align research time frames with those of industry for improved project management. This alignment could also have provided the opportunity for a prototyping test run of the process map with an actual product. However, with the duration of research being only a three-year programme, and with the research being of an emergent nature, this was decided to be unfeasible in this case considering product turnaround times and the timescales with which industry works to.

This approach of case study would nevertheless be more preferable where the research programme, with a longer timeframe than a PhD, is already in contact with a number of willing participants, who have vested interests in the results from the research. During this programme of research it was not possible to acquire such participants who could commit throughout the entire process, due to the time required to find these appropriate contacts.

Additionally, the aim of this research was to encourage SMEs to 'think more effectively' when it comes to environmental best practices. It should be recognised that SME participants may also have their own agendas for engaging with case study research, which might only become apparent through discussion. However, this might have made the development of a prompting method for process mapping less plausible, due to the SME participants own agendas possibly clashing with the research objectives. Additionally, the current process mapping procedure takes full advantage of using a 'generic' method for both NPD and sustainable criteria. Working with case study SME's may have moved the project away from the generic, and more towards the 'specific'. Where a specific method could work for a small group of organisations, the applicability on a wider scale for companies not included within the case studies, may be restricted and therefore less inclusive to the wider SME community.

8.3.2 Data Gathering and Online Databases

Generating accessible contacts with SMEs prior to the research activity would have eradicated the need for spending considerable amounts of time and resources, working with online databases. Where the decision is taken to invest in postal survey research, reducing the complexity of the questionnaire to a smaller number of tightly focused questions may provide a higher return rate from SMEs pressed for time. The industrial questionnaire within this programme of research was created in line with the emergent approach, therefore requiring data over a broad areas identified within the literature review. Had this questionnaire presented less complexity, more engagements may have been apparent from the SME community, at the sacrifice of the number of contextual areas addressed.

When contacting businesses through the method of cold calling surveys, the chance of getting further/continued responses is highly unlikely. Those who did respond to this programme of research did not respond a second time. Therefore it is essential that the maximum value be obtained from the industrial questionnaire first time from those who do respond.

8.3.3 Panel Evaluation in Isolation

Evaluating the process map through a panel of packaging industry professionals was an effective method in gaining meaningful multiple perspectives on the usability of the process mapping tool for SME EIR. Some challenge was presented in gaining consistency in the format with which the industrial questionnaire and the process map were returned to the research programme. It may have been plausible in hindsight to

run the process mapping evaluation as part of a research observation method to record the process mapping procedure in practice.

Evaluating the process mapping procedure through an observational approach would have enabled a more reliable engagement with the external panel by formalising a time and date with which the map could be assessed. This would have provided a more manageable experience for obtaining the results for analysis. Additionally, with the evaluation being formalised through scheduled observation, more attention from the expert panel may have been committed to the activity, resulting in the potential increase of detailed feedback and consistency of responses across the panel. Using recorded observation with the panel evaluation would also have provided the opportunity to discuss points of concern post-analysis with the participant to broaden the available feedback through the discussion of obtained data.

At the time, the decision was taken to have the panel members evaluate the process mapping tool in isolation of the research programme so not as to potentially influence or lever the response of the panel. It was considered that being present within the evaluation may impact negatively on the feedback, by participants not being honest with their impressions of the map through not wanting to disappoint. With the method that was chosen to send the process map out by post, one improvement would have been to reduce the perceived requirements of the panel by combining the questionnaire and the process map together. It was felt that the questionnaire included within the evaluation would complement the covering letter and process map to enable a more thorough engagement with the mapping process. In reality, this resulted in only the questionnaire being returned by the panel, (in some cases without the process map), as the process map was used simply as a reference tool when being critically evaluated.

Comments from the panel voiced that at the outset the complexity of the tool was overwhelming. This initial shock may have been reduced had there been less information to absorb, such as an additional covering letter with instructions and separate questionnaire being omitted from the process. With professionals who are devoting their time to research activities outside of their normal everyday practices, reducing the burden of information may facilitate richer engagement.

8.4 Positive Aspects to Using Mapping Methods

The positive aspects of using mapping has essentially been twofold, both as a research tool for complex data and as a guidance system for small businesses wishing to engage with sustainability. Although initially somewhat overwhelming, using visual methods to engage with complex data has proven to be a vibrant and logical approach to breaking differing datasets into manageable chunks whilst placing them into overall known systems of operation. Working visually adds an additional dimension to the research process which would otherwise be unattainable when working in bullet point format with alpha numerical data.

In essence, we are surrounded by systems and processes which can be visualised, similar to that of a roadmap which can guide us between origin and destination. Within this research programme, mapping was used to plot the elements of sustainability against the elements of product development, but this methodology simply proves the principle of operation in this singular context. Regardless of the orientation of the exercise, all processes engaged with can be mapped visually to some degree or another. Working in this manner enables the user input relevant data, and all criteria at relevant points of process within the overall bigger 'picture'. This then

enables the user to engage with others in a more tangible manner to make more informed decisions which reflect the complexities of real-life situations.

Therefore within the context of this research, using mapping as a research tool reflected the intentions of plotting current research data against the origins of packaging supply chain logistics, whereas for SMEs the system needed to reflect their internal processes of product development. By nature we are visual thinkers, therefore, adding a visual dimension to the work ethic uses the additional cognitive intelligences of: spatial recognition, colour synthesis and comprehension. Using additional cognitive processes simply opens up the opportunity to bridge learning styles with participants in an approach not too dissimilar to 'joining the dots', to finding the bigger picture.

8.5 Chapter Summary

This chapter has discussed the limitations within the current research programme, the alternative approaches which could potentially resolve the limitations, and further research opportunities for process mapping implementations.

Discussion has focused upon working with SME businesses and the need to define an approach which can offer a clear benefit for SMEs to engage, which present values and a return on investment. This is due to SME businesses prioritising the essential day-to-day running of the business over tasks deemed un-essential to obtaining success. SMEs therefore need to be presented with clear factors of buy-in to secure their interest, this being especially the case where the required involvement is complex and demanding upon the targeted SME.

Due to the limited time with which SMEs can assign to additional tasks, the simplification of involvement for an SME is critical while is also the nature of the

questioning and the timing of such. Within this programme of research, difficulty was experienced in gaining continued responses from SMEs. Therefore, questions need to be considered which better inform development in this sector, maximising the usefulness of data from responses.

Additionally, it may be considered that using a case study approach is more effective than using the emergent approach to data collection within this field of research. This is because the emergent approach proved to be restrictive due to initial levels of knowledge being too rudimentary for professionals to engage with effectively within the developmental stages. Using the emergent approach to data collection essentially reduced the ability to ask informed questions within the early stages of research development, where some definition still needed to be acquired. Therefore, using a case study approach with compliant SMEs may allow for more flexible acquisition of early research data, to enable more informed questions to be asked to later research participants.

Furthermore, the time-consuming nature of preparing industrial questionnaires to be sent out to industry was extremely resource intensive in gaining suitable contact details and managing timescales for data collection. This problem also manifested in working with the Delphi method's expert panel, where there was no guarantee of a timed response due to all panel members operating in isolation with individual work commitments. Where industrial questionnaires and Delphi panel evaluations are required, a reduced number of questions and minimal documentation to engage with may reduce the likelihood of error and failure to respond from the research participant.

Improvements within the process mapping tool have been indicated in relation to the running order of embedded EIR themes, and an indication of required levels of commitment from the SME, for each theme at any given point.

The process mapping tool still requires some indication as to the level of priority for each EIR theme within each corresponding phase of NPD. Also, further development should reside around the implementation of cost quantifications and benchmarking systems which enable the SME to self evaluate against a numeric value. Benchmarking systems may use other organisations as potential examples of best practice which the SME may follow to assist with implementation.

Further developments of the process mapping tool have been highlighted within the areas of software implementation and as a signposting method to additional resources, external to the SME. A wide range of services are currently available to the SME, not only from the value to be obtained from the current environmental literature, but also from the broad nature of advisory services within the UK. Therefore the current process mapping tool through further refinements may be implemented as a central focal point of a much wider system, which integrates regulation authorities, consultants and databases for SME consultation.

Nevertheless, none of these developmental opportunities should be seen to detract from the benefits of developing visual tools for process mapping complex information to make it more accessible, and thereby encourage insights and improvements.

The next chapter will address the conclusions of this programme of research, and the contributions to new knowledge which have been developed through it.

9: CONCLUSIONS

9.1 Introduction

The previous chapter discussed the limitations of the research programme and the problems which were faced throughout each stage of project development which impacted negatively. The limitations within this programme of research were part of a learning curve during project development and post reflection and analysis of the success / failure of research activities. Attention was therefore also drawn to potential alternative approaches which might have been implemented in light of the limitations, had this research programme been aware of such limitations in the first instance. Following on from the alternative approaches, future research opportunities were also outlined to illustrate the wide potential for further development within the industry for visual process mapping techniques.

This chapter will provide a summary of the entire activities throughout this programme of research, and the key factors of decision-making which contributed to project direction, focus and success.

9.2 Research Summary

Initial briefing for the research programme was focused on the creation of a novel method for promoting long-term sustainable product development within the UK manufacturing industry. Initial literature review presented the complexity of this area and provided a number of potential areas with which EIR interrelates with product development. A reoccurring theme within the initial literature review was in regard towards SMEs (small to medium enterprises) in the manufacturing sector, and the difficulties which they face when implementing consistent NPD (new product development), and best-practices towards EIR (Environmental Impact Reduction) activities. These areas within the literature review indicated a problem not only from

the SMEs dealing with EIR, but also with external parties such as regulators whose responsibility is to impart authority to be more sustainable. From both sides, lack of communication was apparent with SME businesses seeing little value in working with regulators, and regulators failing to implement authoritative measures upon SMEs due to their smaller size. This causes SMEs to skip under the radar compared to larger higher turnover companies who are more in the spotlight with regulators.

With SMEs being the vast majority of UK business, at 99.8%, this presented an overwhelming challenge in relation to how product development improvements within sustainability could be applied to the general populace of SMEs in manufacturing on such a wide scale. With the huge number of SME businesses UK wide even small improvements in relation to EIR best practice could reap large gains collectively.

The gap in knowledge therefore was how to encourage this large UK sector to change their habits and behaviours. This would require them to begin to appreciate the benefits of sustainable product development and start to make steps, even if small, towards improvements in practices for reductions in environmental impact.

9.2.1 Literature Review

Further research within the literature review indicated a lack of consistency with which SME businesses not only implement EIR, but manage their own NPD procedures. This is due to the consequence of low levels of education being provided within the SME community exacerbated by poor communication practices in particular among the people which they work with. This means that SMEs become fixed to company specific routines and behaviours which leaves them with an overoptimistic view of their own performances and unaware of the true value within making internal improvements. Internal improvements require time and resources of

which SMEs are typically short, while additionally requiring internal assessments to compare against benchmarks for improvements.

This lack of reflective and reflexive practice within SMEs leaves them; isolated within their supply chains; at the mercy of others in relation to information with which they are provided; overburdened by requirements which SMEs must adhere to; and unaware of the potential scope for assistance which is currently available. Overall, this highlights a gap in knowledge for SME organisational practices with their failure to see the importance of environmental best practices. This not only potentially damages the environment, but misses any potential profit gains attainable through improvements.

The challenge of the research programme was then to propose a new system which moves SMEs away from eco-literature and towards a more eco-literate systematic approach to EIR through practical engagement. It was proposed that the approach should be generic for all users, as an open ended method which provides rich engagement in NPD procedures, EIR, their application and potential benefits within the organisation.

Through application, the SME should quickly grasp the concepts of EIR without effort, while observing the relevance of, and interrelation with every day product development activities. This way, best practice could then be integrated as an integral part of current NPD procedures in a way which is not only informative but becomes beneficial and essential to the users.

9.2.2 Methodology

Following the review of potential methods it was decided that this programme of research should apply a mix of both qualitative and quantitative data which would work sequentially to support an emergent approach to practice. Because the literature review indicated the complexity of sustainability with which SMEs currently struggle, it was decided that it would be worthwhile to go back to the basics of understanding the challenges which the manufacturing sector face to address any assumptions. To do this the research programme would have two objectives which would work in sequential nature:

1. The first objective would be to understand the procedures of the product development supply chain, with which products are designed, produced and dispatched. Within this chain, packaging development is an essential factor for product delivery and is a significant environmental concern; due to the tonnage of packaging waste submitted to landfill each year by product producing companies. Understanding the intricacies of the supply chain system would therefore be essential to be able to pin point crucial factors for improvement through contributions to new knowledge.

   Synthesising a diagrammatic representation of the supply chain system for this purpose required working with industrial professionals who operate within this area. Their contributions involved discussion and confirmation of the accuracy of the supply chain diagram to build an overall system framework for future reference. The Delphi research method was chosen as the most appropriate approach to gaining multiple perspectives throughout the course of the research programme, from a panel of industrial experts. This approach was valid for the development of the supply chain diagram with which to raise further points of discussion with the Delphi panel, and final evaluations. Therefore it was seen

that using panel evaluation would provide the broadest range of critical review for topics proposed within the research programme.

2. The second objective which would run sequentially with the development of the supply chain diagram would be to uncover those factors of EIR which SMEs currently struggle with the most. Once identified, factors for concern were plotted within the sequentially developed process map to enable further points of discussion and focus for the proposed SME EIR toolkit.

   To achieve this, combinations of panel discussions were implemented alongside the development of an industrial questionnaire, which was sent out to the SME community. The industrial questionnaire contained the most common factors of EIR concern with SMEs, identified through the literature review and Delphi method's expert panel discussions. Further project refinement and focus was then derived from the industrial questionnaire responses, which indicated where the most crucial areas of negative impact within SME practices need to be addressed.

In order to refine the areas to include within the industrial questionnaire, and accumulate the responses during the emergent approach to research, affinity diagrams and process mapping / concept mapping techniques were implemented. Affinity diagram techniques enabled the categorising and prioritising of areas of concern identified through both literature review and Delphi expert panel evaluations. In addition the affinity diagram approach offered indications as to current issues via the data analysis.

Following on from affinity diagram use to specify issues, process mapping then became the first and foremost method in visualising all information in regards to the research programme development. Not only would process mapping enable an

alternative to text-laden formats, the visual nature would enable ease of access to content data whilst facilitating discussion in relation to areas of concern within the overall supply chain system.

It was decided that these research methods would provide the broadest application to building context over the broad SME sector, to provide generic data in relation to areas of further focus. This would be part of a sequential, emergent and iterative approach to both quantitative and qualitative data collection, involving a Delphi method of expert panel evaluations.

9.2.3 Project Development

Business database access was used to draw together a list of relevant SME supply chain professionals who could be invited to engage in the Delphi expert panel evaluations. After some refinement, the final panel participants were a combination of: waste regulation consultants; packaging regulation consultants; environment agency consultants; packaging designers; packaging development research organisations; environmental regulation consultants; SME businesses both in product manufacturing and food manufacturing; packaging supplier businesses; and a number of other practitioners who contributed throughout the research programme.

Using this breadth of consultants enabled the research to inform the creation of a general system design which reflected the packaging supply chain with which packaging SMEs operate, and additional parties within that chain. Challenges faced by SMEs, highlighted through review of associated literature, informed further points of discussion with the industrial practitioners. Responses to these discussions enabled reconfiguration of supply chain system process mapping, to indicate essential factors which would drive the industrial survey questions.

By improving the systems of communication *visually* it was anticipated to empower the SMEs to apply more leverage within their supply chain, through more informative and targeted discussions with suppliers.

9.2.4 Industrial Survey

Analysis of data was overwhelming due to the broad contextual nature of the questions asked within the survey. Initially Microsoft Excel was used to transcribe the data into categories and then create quantitative visual indicators of the data, using the available visualisation tools which this spreadsheet provides. However, this approach proved to be ineffective due to the broad nature of this research survey needing to present multiple sets of singular quantities for comparison.

Additionally, industrial data obtained from the SME community had been segregated into four more feasible SME size categories. This was because SMEs were generally classed together independent of their actual size. For example, an organisation with 1 to 49 members of staff is classed as an SME, and so is an organisation with 50 to 250 members of staff. Additionally, even through some literature defines a 'medium' company as those who are 50 to 250 members of staff, this size differential is still too broad to group perceived industrial practices across the whole sector.

Therefore the SME categories were split into four more equal divisions, to enable further discussion as to the differences within environmental management and awareness, at each of the four new SME size divisions.

A process mapping technique was developed through a number of iterations to build a refined version of the supply chain system, from which the industrial questionnaire factors were derived. Data from the industrial questionnaires were recorded on process maps to provide visual indications as to where values were either high or low from

SME responses. Using this mapping process enabled deeper discussion as to areas of concern, and further focused the research to develop an overall SME toolkit for EIR. Separating the SME classification into four sizes enabled observations as to the differences within each size classification, and the proficiencies of EIR best practices in operation.

It was found that the largest of those size classifications of companies, with a range of 200 to 250 employees, demonstrated equal difficulty in implementing sustainable best practices, as did those SMEs which range of 10 to 49 employees. The SME size classifications demonstrating most proficiency were the middle sized categories of 50 to 99 and 100 to 199 employees. This indicated a possible balance point for EIR best practice and organisation size, and suggested that the smaller the organisation the less time and resource they have available to understand and take action through additional responsibilities. The data also suggested that the larger the organisation the more potential communication divisions within the company, which adds complexity to implementing new approaches to best practice.

As a result, the optimum sized SMEs who appeared to be most confident in working with and implementing EIR best practices were those within the median range of employee sizes.

9.2.5 Final Design

As part of the sequential and emergent approach, a large number of key factors were identified through the development of the process map which indicated a requirement for improvements in SME best practice, and further defined focus. These factors were then grouped for potential inclusion within the final process mapping toolkit for SME EIR. Additionally, a critical review was performed of the current process mapping

diagram to identify points for review which would enable applicability for use within the SME community. The initial diagrams worked well in enabling the research to attain an overview of emergent issues *looking in*, whereas the final process mapping orientation shifted approach to a more informative perspective, enabling SMEs to be *looking out*. It was decided that the process mapping methodology would aim to reflect the running order of NPD procedures rather than including the whole supply chain, and subsequent EIR criteria would then be embedded within respective points of the NPD process.

Further research was conducted to improve the level of detail for NPD procedure to be included within the new map. This included integrating stage and gate evaluation procedures prior to activities within each phase of NPD. Previously defined EIR factors were then filtered into six key themes of best practice, where each key theme encompassed the widest range of factors as a collective. For example, the previously identified factors for improvement of: material reduction, carbon footprint reduction, waste reduction and innovation, all fit into the overall key theme of 'Transport Efficiency'. The intention being that each key theme of best practice would encompass the widest range of benefits through implementation.

Definition of each key factor was justified through further literature review; where each cumulative factor was investigated to derive its suitability for assignment within each umbrella theme. Further literature review was then conducted to facilitate engagement with each key factor of best practice, by defining a number of various actions for implementation and subsequent attainable benefits as a result of effective execution. The process mapping method was then used sequentially, supported by further literature review, to validate the connections between each key factor's action and their respective point along the NPD process.

The value here has demonstrated to the SME, how early considerations of each key theme of best practice, and the indicated actions for implementation, are consequentially interrelated to beneficial effects further down the industrial timeline.

All EIR key themes of best practice, their actions and their benefits, placed in relation to the NPD stage and gate timeline, were kept generic in application. The purpose of keeping all elements within the process mapping tool generic was to enable the wider majority of SME businesses to find familiarity with embedded elements of the process mapping tool. The decision to keep the process mapping tool generic ties into the original literature review concerns, which highlighted that all SMEs operate individually under their own routines of behaviour and traditions of industrial practices. Therefore, the generic nature of the process mapping tool would remain less specific, but still enable the communication of the value embedded within it to a much broader SME community.

The process mapping tool in its current format would indicate where EIR NPD opportunities reside for those with more knowledge, while additionally educating those with less, as to steps required for effective sustainable NPD strategy towards environmental impact reduction. Therefore, the process mapping toolkit demonstrates value in prompting the user to ask more informative questions in regards to EIR at respective points of NPD practice.

Encouraging the user to ask more informative questions, empowers the SME when working with others by simply building a better platform for communication and engagement with specific environmental topics.

9.2.6 Final Evaluation and Limitations of the Research Programme

For the final evaluation, nine Delphi panel members were selected to provide input on the process mapping tools effectiveness to visualise EIR for SME users, and the ease-of-use for first-time participants. Final evaluation Delphi panel members were selected from differing parts of the previously defined supply chain to provide multiple professional perspectives. Consultant panel members were therefore chosen from the areas of: packaging design, environmental waste, regulation authority, packaging research, Trade Federation, and SME businesses in both product manufacturing and food manufacturing sectors. Industrial questionnaires were sent to all panel members in relation to the critical review and potential validation of the research, supported by a blank version of the final process mapping tool for contextual purposes.

9.3 Future Research Opportunities

The aim of this research programme has been to investigate whether in practice the principle using a visual language in combination with mapping techniques, simplifies the complexity of environmental data for SMEs. This was in response to an identified need for an SME framework which can deliver the principles of environmental best practice in alignment with current NPD practices. This programme of research has subsequently created this framework, which works as a generic method to prompt SMEs into engaging with EIR criteria. The functions of this tool operate as an educational process, which informs not only actions for implementation but also potential benefits for the organisation through use. As a result of the learning's within this programme of research and feedback from the expert panel through evaluation, there are a number of avenues for further research which hold great potential within industry for further application of this method.

9.3.1 Further Iterations of Development

The process mapping tool will benefit from a number of identified critical improvements, which will further assist SMEs when interacting with the process, and facilitate the extraction of added value during use:

1. *Sequence of operations within the tool:* evaluation panel members voiced that the running order of EIR criteria and their connectivity within NPD could be refined to improve engagement. In this thesis all EIR key themes are process mapped into Phase 1 and Phase 2 of NPD, and are listed from numbers 1-6. Further mapping improvements should revise the key themes of EIR and integrate them within NPD through a system of priority. For example, 'working with suppliers' is essential in developing effective packaging solutions, but engagements of this type are more prevalent and important within the later product development phases, rather than initial conceptualisation phases. Although some discussions with suppliers need to be initiated early within the industrial timeline to be able to estimate future costs, the context of the discussions are more important once the product offering has been decided.

   Additionally, key themes within the map providing instruction towards 'packaging reuse systems', hold a much greater priority further down the industrial timeline than they do being considered within the teething stages of product development. Therefore, whereas all sustainability key themes are currently linked to all parts of NPD, there should be a visual method of indicating where each of them holds the most priority within a given point of the industrial timeline, and the extent to which they must be considered. Improvements here will enable the SME to evaluate the required resources to effectively implement key theme activity within a specific point of the process.

Currently there is no indication as to how much attention to detail is required for each of the themes at any given point.

2. *Industrial benchmarking:* in its current phase of development the process mapping tool works as an indicator of areas which need to reduce environmental impact, and enables a snapshot of current levels of engagement in these practices. This currently works to provide feedback as to the organisations holistic approach against the areas contained within the map, but provides no official industrial levels to make comparison. Therefore, future iterations of mapping development may embed a benchmarking system which contains values from industry which originate from successful organisations currently implementing the key themes of best practice. This would then enable the SME organisation to not only evaluate their own performance, but to make comparisons to other successful organisations implementing improvements from the same factors, once the evaluation against the embedded criteria has been completed.

   This would most likely require further research into operational activities of SME organisations through case study method. This would be in order to identify numerical values against activities, which have been determined to be EIR best-practice.

3. *Cost savings quantification:* built on the foundations of potential benchmarking, the process mapping tool could provide SME organisations with an indication towards quantifiable financial gain. The current process mapping tool does indicate which EIR key themes indicate a cost saving, but does not currently provide a numerical output.

Enabling the SME user to obtain a numerical output in relation to cost savings, may go some distance to encourage further engagement with EIR and the process mapping tool as part of the NPD strategies. One of the highest responses from the industrial questionnaire was in relation to the need to reduce costs. This is a major driver for SMEs and one which may provide leverage in changing organisational behaviour in favour of environmental best practices where improvements can be identified. Within the current programme of research there has not been time to benchmark and implement numerical cost-saving measures within the current process map. This is due to the research programme aiming to test the principle of a visual method for EIR engagement, as a precursor to further more detailed applications.

It is important to note that the value within the current process mapping tool resides within the inaction of engagement. As an educational process this works well to inform and direct those with less knowledge, as to the procedures involved within sustainable best practice and the opportunities which are potentially available to them.

This prompting method serves to push SMEs in the right direction and encourage them to begin building bridges of communication within the organisation and those with which they work externally. For this reason the current process mapping tool is generic in approach, to broaden the application across the largest majority of SME users. Any further improvements within the process mapping tool, such as including benchmarks, and cost quantifications, will move the process mapping tool into the area of being specific rather than generic.

If too specific then the application becomes narrowed, as effectiveness relies more on the data embedded within the map to provide indication for improvement, rather than the SME to define what they deem to be important for themselves. This is the greatest

difference between the current process mapping tool and other sustainability tools currently available.

Through being generic, the current research programme does not dictate to the SME what they should or should not be doing; moreover it simply provides indications as to points of discussion which hold great benefit for the organisation, outside of practices which would normally be seen as routine behaviour. Although customisation is important to some degree to enable ownership of the tool, the simplicity in this approach already reduces the isolation effect for SMEs. Therefore, the current tool acts as a 'bluffers guide' to sustainability, rather than a rigid and authoritative evaluation framework.

9.3.2 Software Customisation

Further research may provide the opportunity for digitisation of the process mapping tool into a software format. Moving the process mapping tool into a software format will enable the SME users, through a selective process, to pick and choose the areas with which they may wish to either learn more about, or implement within their organisation.

As a visual process, a software solution of the process mapping tool may present a number of drop down menus integrated within the timeline of generic NPD to reduce the overall visual complexity. Potential product offering can be embedded at the beginning of the industrial timeline, and then subsequent indicators may be highlighted from the software tool to show where improvements can be made within the process.

Selections could then be made by the SME users as to those indicators with which they wish to pursue, to then access benchmark quantifications as to potential savings

from adherence to the suggested procedure. Using software solutions would enable the tool to remain generic, but become specific upon customisation from SME engagement.

9.3.3 Partnerships and Extended Use

From the side of the regulators, further research with the process mapping tool may work as a combination of wall chart diagram and online database. SME businesses would be able to access the tool online to provide indications as to where potential improvements could be made within their organisation. These improvements could then be temporarily plotted upon the wall chart diagram within the organisation which facilitates discussion and product planning. The online tool when required, could then essentially direct the SME organisation to the appropriate resourcing to further investigate the area with which they wish to invest, or find contacts with which can assist.

As a two-way process, regulation authorities could additionally update or edit the information embedded within the online resource to further inform those who access the tool when new regulation or legislation becomes available. This would subsequently side step the current issue of disseminating regulation procedures to the numerous, geographically dispersed, SME businesses. In return, as the SME updates their current status online as to their adherence with the criteria within the map, regulators can observe that SMEs are subsequently compliant.

Furthermore, potential business opportunities may be realised through using an online system endorsed by the regulators and used by the SMEs, including rated packaging, and environmental consultant services. Such opportunities could be prompted in response to data entered by the SME organisation. This would furthermore resolve the

issue that SMEs are currently isolated within their supply chains and fail to be able to access consistent and reliable advice when seeking environmental improvements.

Additionally, from the side of consultation, SMEs could potentially fill out the process mapping tool either online or via hardcopy, which is then sent to environmental consultants. Environmental consultants could inspect the data embedded within the map provided by the SME assessment, and return to the SME with an environmental best practice report on potential improvements required by the organisation upon information provided. Therefore, as a consultant tool, process mapping of sustainability within NPD, could be sent out to SME organisations to help define through collaboration where potential improvements reside, as part of a fixed checklist template.

9.3.4 Dissemination of Existing Complex Environmental Data

In relation to the droves of existing environmental literature with which SMEs currently struggle to comprehend, the process mapping tool may work as a signposting method which provides indicators in regards to contextual information. The current format of environmental documentation for SMEs to encompass is heavily laden within PDF, Word documents, and online textual resources. Process mapping prompts may prove effective in guiding SMEs toward the required resources of data, either available online or accessible upon request from government resources.

This solution could use the process mapping tool as a networking method between all available environmental resources. This would enable the SME to prioritise the information they need to know, rather than being weighed down sifting through endless data to define the areas of importance. For example, for SMEs working with packaging regulations for waste, they may use the process mapping tool to prompt

discussion into potential cost savings for waste management within packaging reuse systems. If packaging reuse systems are selected within the process mapping tool at the appropriate point of NPD procedure, they may be directed to specific resources which can facilitate advice within this area.

This would then provide the SME with a relevant navigation method to identify areas in relation to customised EIR best practice, while making full use of the currently available, and rather extensive, existing environmental guidelines.

Metaphorically, this approach is similar to an SME within a library where the library represents the endless amounts of environmental information currently on offer to small businesses. The process mapping tool could simply act as a librarian who steers the reader towards what they may need. The SME need only use the tool to define their requirements through self-evaluation, for the tool to identify sources of up-to-date information to further inform their practice.

This approach would indeed be a long-term goal as the structure required to implement the service would be extensive. That said, once a software version of the process mapping tool has manifested it is simply a few steps away from being integrated as an online resource, which can then be hard-wired into existing databases and networks for the SME.

As the current process mapping tool resolves the issue with SMEs interacting with complex environmental data, steps need only be taken which enable access to the tool on a wider scale. Therefore, nationwide SMEs, industrial practitioners and consultants, regulation authorities, and online databases, need then only connect to the online tool to open up the breadth of opportunities for SME businesses regardless of their size and capacity.

This research programme has additionally indicated that it is not just the complexity of environmental data which is at fault, but the current methods of communication of such data and ease of access to it which need to be improved.

9.3.5 Results and Future Research Opportunities Summary

Panel evaluation members were unanimous that the process mapping method works well, to visually disseminate the overall complexity of environmental data attainable for product producing SMEs. The mapping narrative enabled the panel members to plot the course of action of NPD activities, with consideration towards EIR factors adjoined at their respective locations within the industrial timeline.

Panel evaluation members were unanimous that the process mapping tool is comprehensive in regards to EIR data, and that it works well in demonstrating the importance of EIR within each of the defined key areas, through the subsequent actions and benefits from implementation. This method of EIR dissemination therefore works well to prompt the user into using potential avenues of best practice, while additionally educating the user as to the relevance of these areas within overall NPD process. Potential areas for improvement within the process mapping tool reside within the expansion of use into digital formats and collaborative measures with complementary documentation.

Digitising the current process mapping tool would enable the user to manipulate the generic approach to be more specific to the individual SME. This method could then work well with additional sources of information as a signposting activity, to work in harmony with existing environmental online data, or published material from government authorities. Further research activity would enable the process mapping tool to demonstrate connectivity to regulation authorities and industrial practitioners

which are available to SMEs for advice and guidance. The process mapping tool could then provide a central hub to SMEs as a guide to environmental impact reduction, steering them to the required resources defined through a series of selection processes when engaging with the toolkit.

Further research opportunities may be to integrate cost quantification and benchmarking methods to provide numerical outputs from the process mapping tool. This may work well where SME management need immediate feedback to justify further investment with the areas suggested for improvement.

9.4 Contributions to New Knowledge

This research has shown that a visual mapping process for engaging industry is a valid avenue for further research.

The significant contributions to new knowledge have been on three fronts.

The first of these was in relation to using a process mapping method as a research tool, for dealing with qualitative industrial practices and processes, and quantitative industrial data. Additionally this has been used in relation to using process mapping as an industrial tool to visually disseminate factors for environmental impact reduction into NPD timeframes, to facilitate sustainable long-term product development.

The second of these is in relation to using process mapping as an industrial tool, to reduce the complexity of environmental data and facilitate engagement while communicating benefit to those engaged in the visual mapping and review process.

The final key contribution is in relation to understanding the influences of organisational size on best practices within SMEs, where the median size range are large enough to invest time and experiences in required processes, whilst small enough to maintain effective channels of communication.

Key contributions to knowledge are as follows:

1. *Mapping industrial process as a research tool and EIR into NPD::* Using process mapping enabled a tangible and visual engagement with the research data, while facilitating discussions which informed further research activity. Additionally, using visual process mapping techniques was observed to combine EIR factors with their respective origins and interactions within NPD. This prompts and facilitates education for the user a stepped narrative to implementation.

2. *Reduction in complexity of environmental data:* Using visual process mapping techniques has proven to be an effective method in segmenting environmental data, in a way which facilitates engagement while communicating the true value of each core element. Using visual indicators for complex data encourages tangible interaction through usage and challenges the nature of complexity when dealing with EIR for SMEs.

3. *Tipping point of SME best practice:* This research program has indicated that there is an optimum size within the SME classifications which support best practice over all others, at the 50-99 employees range. Further research may choose to investigate the core reasons for the proficiency demonstrated within the 50-99 size category, for the potential transferring of core enablers to other SME organisations.

This study challenges the assumptions that environmental data is overly complex for organisations to encompass and interact with. This study also challenges the assumptions that SMEs are less proficient in appreciating the value of sustainable implementation within their organisations.

It is not necessarily the message of environmental best practice which needs to be improved, but the methods of delivery and communication of best practice which requires further attention. SMEs inherently do see the value in fostering new approaches within their organisations, but currently fail to see how such improvements are relative to their overall success and long-term goals.

Facilitating a rich engagement with EIR opens up the opportunity for broader application and subsequent behaviour change where avenues of benefit are identified. It is the initial steps of challenging SME behaviour, which are most crucial in securing further long-term engagement with sustainable activities. In order for SMEs to be encouraged to invest valuable resources within areas such as: environmental consultation, regulatory procedures, improved process designs and software toolkit purchase; they must first build the foundations in awareness, of EIR best practices and the areas over which they have influence.

In order to challenge the perceptions that best practice for environmental impact reduction is time-consuming and unprofitable, SMEs must first engage with experiential discovery which is indicative of gain, and applicable to the organisation.

Enabling SME organisations to grasp and pinpoint the benefits of EIR throughout the course of NPD procedures, not only empowers the SME to ask more informative questions of those whom they work with, but increases the likelihood of making changes which encourage more long-term and sustainable, product development.

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11: APPENDIX

Appendix 1.1: Initial Scoping Letter to Envirowise

Below is an example of the initial letter which was sent out to Envirowise, to attempt to find external professionals who could input on the research development post literature review:

Dear WRAP.

My name is Thomas Woods and I work within the research department for Manufacture and Engineering at Northumbria University, working jointly with Northumbria School of Design. I am currently now 5 months into a new PhD research project which I see as a real opportunity to make a difference within packaging and resource efficiency for sustainable product developments. Part of the main focus at the moment is looking closer at best-practice in how pressures are managed within companies to align with environmental legislation, or capacities are used to maximise resource efficiencies.

I have begun to structure in theory what I believe to be a generic framework for organisations that wish to engage with impact reduction. The problem is that my work is mostly founded in literature and now requires more specific experience / insight, to be able to focus more detailed investigations.

We are hoping that I can make contact with your organisation in the most convenient manner, or arrange a meeting at a suitable point in the near future. I would like to be able to pull on your critical expertise to help refine my understanding of implementing resource efficiencies as a process. Over the next three years I would very much like this project to make a real contribution towards a more sustainable future.

I look forward to hearing from you in the near future.

Best Regards

Tom Woods

Appendix 1.2: Initial Questionnaire to Envirowise

Below is an example of the initial questionnaire intended for Envirowise to help define areas for further research focus. Areas within were identified through initial literature review.

1. What are the main reasons for driving new Packaging Creation within organisations?

   New Products / Brand & Image / Reducing Costs / Enviro & Material Concerns / Innovation / Regulatory Compliance / Consumer Pressures

   Other : (please briefly specify) ☐

2. Please place the 'chosen' answers from the previous question in order of importance (The 1st being most important).

   ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

3. Would you say that the above answers are the main Criteria used when creating new Packaging briefs & specifications?

   Yes No: (please briefly specify others) ☐

4. Are any specifications received from sellers / Retail, in relation to the standards of Packaging Criteria?

   No. (Go to Q:6) Yes: (please briefly specify) ☐

5. Are any of these specifications passed along to the suppliers?

   No. Yes.

6. Does Retail request any technical Data in regard to Packaging specifications delivered to them?

   No. Yes.

7. What would be your main barriers to implementing more Sustainable Innovations with Packaging?

   Available Internal Resources / Lack of Knowledge / Supply Chain Isolation / Dependence on Suppliers / Unclear Obligations /Financial Capacity

   Other (please briefly specify) ☐

8. Are you aware of any current innovations that happen within the supply chains, or any innovations that happen outside of the current supply chains?

   No. Yes: (What?) ☐

9. Are any current resources allocated to the sourcing of better opportunities within current supply networks?

   No. Yes. (Please briefly specify) ☐

10. Where is the Design and fruition of Packaging creation put into practice?

    In-House; (Go to Q: 11) / Consultant – Consultancy; (Go to Q: 15) / Off-Shelf Packs; (Go to Q: 20) / Packaging Supplier; (Go to Q: 24)

    ☐

Other:

11. What resources are used to inform the design process and sustainability of newly desired Packaging Creation?

    Toolkits / Internal Expertise / Packaging Consultant / Packaging Supplier / Design Company / None / Other

12. What are the Criteria used to prioritise when making choices about new packaging Design?

    Material Reduction / Recycling / Cost / Brand / Logistics / Enviro Concerns / Disposal / Processes / Fit for Purpose / Material Choice / Innovation

    None / Other

13. Are any external resources involved, if so what do they contribute and what part do they play?

    No. Yes: (please briefly specify)

Appendix 1.3: Transcript from Packaging Federation Consultation

TW: So there is some recognition out there at the moment that SME's are finding it difficult. Mr Searl?

DS: There is yes, I think that in many walks of life, not just this one, I characterise the industry with a 'product', quite honestly, if SME'S aren't getting that sort of service, than they need to change suppliers.

TW: Let's say an SME company would want to design their own Packaging, they have an idea what they want to protect their product and how they want it to look, I know that specification can happen at different parts of the chain, but is more often than not, that the SME's will struggle to design their own Packaging?.

DS: There are 'any-number' of packaging consultants out there, any number who know their way around a heck of a lot better, I think sometimes it's just a question of asking some very simple questions.... to be honest life's just so easy now as you have the likes of Google, Packaging Press, Packaging News, have very substantial databases of companies and so on...

TW: So do you think that for the SME's, the biggest problem that they have is understanding their place in things, and what's actually available to them on a grander scale.

DS: I think that's very well put, yes, very well put, exactly right.

TW: And that just simply be in terms of the Processes that are available, the opportunities that are available, in terms of suppliers and what they can offer?

DS: Yep. I mean any reputable company is going to be fully aware of issues like essential requirement regulations, they will know that they themselves with have limitations in terms between the blurred line between packaging that is optimum to protect the product and packaging that is used for promotion, will always be a very blurred line, but the packaging manufacturers ought to be aware of that, and quite honestly, one of the things you 'perhaps' you should be looking at, is almost a 'check list', if you're looking for a packaging supplier, these are the fundamental questions you should be asking of it. Are you aware of the Essential Requirements regulations ETC?

TW: Like a specification criteria isn't it. Like a checklist they can be asking to better inform their practices.

DS: Yes that's right, absolutely.

TW: With the PER, when SME responsible to place upon the market, what they put out there has to fit those criteria's, within obligations, do you think in some cases where it is overly specified or not appropriate, is because they're not asking the right questions of the suppliers in terms of what they are being given?

DS: I'm pretty sure it is. But I'd be surprised if any SME gave it a second thought, I should think 95% of them have never heard of the essential requirement regulations... I mean I could point

you to people who have got larger packaging companies, that haven't even heard of the essential requirement regulations, people within Packaging companies, because they don't get involved with that bit. Because many packaging companies discharge their obligations via compliance schemes, so they don't have to bother about that, they get someone else to bother about it.

TW: Do you think that any of the elements of the PER regulations are an issue on a big scale with the SME's?

DS: No I don't really to be honest with you, mainly because what they are doing; unless they are doing something that is very very different from what is already out there in the market place, what they do will already conform to a type that has already been tested if you like.

TW: I spoke to packaging consultant, SME's don't realise the potential of what they actually have with what's available to them out there.

DS: Yea, oh absolutely yea, well I mean the first thing to do, is ask your supplier? Isn't that what most of us do in the B2B interface, you rely on your supplier to provide you the best service, if they don't, you kick them out and find one that does.

Appendix 1.4: Rejection from Professional Panel

Below is an example of the rejection from professionals within industry when requesting further information. This was due to a lack in contextual understanding within the early stages of the research programme.

Good morning Thomas,

When I agreed to provide some input into your project, it was on the assumption that you had some sensible appreciation of the workings of the packaging supply chain. Indeed, it's difficult to see how you can approach the more complex issues of "sustainability" within this supply chain without having a fairly detailed knowledge of it. It seems from your questions to date that your knowledge base is fairly rudimentary and, regrettably, I don't have the time to spend the many hours that are necessary to give you a good grounding in how our industry operates.

I suggest that you become a student member of The Packaging Society and avail yourself of their training facilities.

Once you have acquired a much better knowledge of the operation of the supply chain, I'll be happy to give you my views on the complexities of "sustainability" within it.

Best wishes & good luck,

Dick Searle

Appendix 1.5: Packaging Specification with External Professionals

Below is an example of the email correspondence used with external professionals to define the packaging supply chain specification processes and the key operatives.

Hi Thomas,

From my experience (and I am not a packaging designer) the specification and design takes place at different parts of the supply chain. For large organisations for the likes of Tesco they will have an in-house team that will specify the minimum requirements for the packaging of particular products. It will then be up to the supplier to exceed these requirements. The requirements will be on cost, size, weight and material type. There are also requirements on if it has to be shelf ready or not. A product has to unpacked and put on the shelf within something like 10 – 20 secs or it is outside of spec.

For SMEs the design option is quite limited because of lack of purchasing power, usually they will buy standard packaging from a catalogue so it doesn't give them much scope for innovation. Don't know if this helps you that much, if you need anything else just get in touch.

Andrew McCaffery Director of Consulting

Hi Tom,

I've had a quick look; they are useful diagrams. I think you need to consider the role of the "importer" as much of UK obligated packaging enters the market this way. This introduces legal implications (that may initially sit with the manufacturer/ converter) further up the chain and also under the Essential Requirements Regs. This can make it difficult to understand who has the design responsibility because although the importer is legally obligated the level of control will be minimal and will depend on how much they can or want to impact the supply chain. Very few businesses have heard of the Essential Requirements regulations, never mind seek to comply with them. More worryingly, many trading standard's officers have not heard of them either. Do you plan to recognise the fact that small businesses won't be involved in this (i.e. <2m t/o and/ or <50t handled) - this will impact the level of sustainability that can be achieved? I trust this is helpful

Chris Wilson RBS Consultant

Appendix 1.6: Defining Industrial Questionnaire Essential Criteria

Below is an example of the bullet pointed transcripts taken from external professionals, when & questions in relation to critical areas for inclusion within the industrial questionnaire.

European Environment Agency Bullet Points:

1) *In your opinion, where would you say the biggest improvements are needed in Packaging Sustainability that present a difficult challenge for SME's?*

- To reduce all Packaging waste, about the minimisation of the packaging.
- Innovate with the Logistics of one way Packaging, instead of simply having one way trip packaging.
- Most systems are one-way trip systems.
- Refill packaging is going down, being replaced by one-way container. Mostly in relation to Tertiary packaging for the transport of Packaged Products, protection while in transit, then gets thrown away.
- SME's had good systems once, but now going more into one way containers.
- Universal types of containers may be a benefit (but difficult because of the Marketing) hard to define product like this though.

2) What are the potential limitations within existing supply chains, in terms of improving packaging sustainability?

- The globalisation of very complex supply chains, different materials, plastic packaging more complex, different types of plastic being used, cross polymers and mixed polymers.

3) If we look at Packaging and sustainable packaging, what would are the financial benefits for people to improve it, in terms of production, cost benefits?

- Lightweight Packaging, less material, to optimise transport.

Pat Starke Packaging Consultant Bullet Points:

1) *In your opinion, where would you say the biggest improvements are needed in Packaging Sustainability that present a difficult challenge for SME's?*

- Sourcing recycled materials of quality, is sometimes a barrier for them, thinking that the recycled material, say card, is not that good for them. Sourcing the correct sustainable materials and knowing where and what to pick.
- For example if they want a clear window, they will just go for the default instead of something that has been recycled or is recyclable.

2) What are the potential limitations within existing supply chains, in terms of improving packaging sustainability?

- Being able to get a handle on the *'Carbon' footprint* of their distribution chain, haven't bothered to find out, how far things have come, how far they have been delivered and have they been delivered sustainably.
- Trying to work out how much fuel they are burning, or how they can offset it.

3) If we look at Packaging and sustainable packaging, what would are the financial benefits for people to improve it, in terms of production, cost benefits?

- I don't know if they get any tax breaks for it, but financial; might improve the brands outstanding amongst the consumers, if could say were carbon neutral as a brand would stand for something
- In future for a while will become a really good USP, from an intellectual point of view they may benefit, but not sure if they get any tax breaks from it.

Appendix 1.7: Refining Industrial Questionnaire Essential Criteria

Below is an example response from an external panel member in relation to improving aspects of the pilot industrial questionnaire, in relation to the clarity of content.

14. In terms of managing or enquiring within environmental obligations, what 'external' resources are used to inform or update your knowledge base? *(please briefly specify)*

1:	2:	3:	4:

> Have to give them choices here, as to what you're talking about as i don't think that they will understand necessarily.
If you're going to pull data out, best if there is 6 or 7 options so that they can pull one out and specify "other" if there is another, to help them be prompted.
> It may be too early in the questionnaire to have an unprompted question as they may just switch off at that point.

15. As a consequence of using these resources, how effective have these been in improving your credentials and knowledge base? *(please briefly specify)*

1:	2:	3:	4:

16. Of all the above mentioned Regulations / Legislations, even if not-obligated, are you aware of any
Tangible Business Benefits, as a result of investing in forms of Compliance? YES : *(please briefly specify)*

1:	2:	3:	4:

> What business benefits would be anticipated, because 'any' compliance is fundamentally a 'Tax', it sets up a level playing field for them all, i doubt any business gets any benefit from Tax in Regulations, it's a pure 'cost' to them.

> I mean if they go away and do Packaging Minimisation and use less packaging, there is a consequence of it, there Bill will go down, say card, £2-3 a tonne compliance bill, i mean when that's broken down to pure pack, it's not going to make or break a business, i don't even think they would see that flowing through, its near enough loose change at that point.

> I don't think that compliance here is the key aspect in producing a business benefit. It's kind of like 'Beyond Compliance'. It's more like question 9. I would just say question 8 i would take out completely, cos i don't think it makes a difference, i don't think there is any advantage at all to compliance, business advantage or business benefit to it.

Appendix 1.8: Supplier Industrial Questionnaire

Below is an example of questions, 7, 8, 9, from the packaging supplier industrial questionnaire, where the intent is reversed to focus upon the SMEs from packaging supplier perspective.

7. Which areas would you say your organisation was competent in, when working with prospective SME clients? **Please rate 1-3 in each box:**
   1: No inherent knowledge / **2:** Basic understanding, we get by. / **3:** Extremely competent, we push boundaries.

Packaging Sustainability		Sustainable Supply Chain	Brand / Marketing
Reducing Costs	Logistics Efficiency	Managing Waste / Recycling	Reducing Carbon
Packaging Re-use Systems	Expanding product R&D	Understanding Needs	

8. During the process of packaging choice with SME's, do you communicate any 'Technical Data' in relation to them fulfilling their specific Regulatory obligations and potential requirements?

YES	NO

9. How would you rate on average, the ability of an SME to be able to 'specify' their own Packaging requirements in terms of;
   Please rate 1-3: **1:** Poor / **2:** Sporadic / **3:** Consistent

Packaging Sustainability	Regulatory Compliance

Appendix 1.9: Covering Letter SME Postal Industrial Questionnaire

Below is a covering letter which was sent out with the first batch of SME industrial questioners to the SME manufacturing sectors.

Dear Participant.

My name is Tom Woods and I work within the University of Northumbria as a PhD candidate, and wanted to write to you in relation to a piece of work we are currently engaged in. We are building a joint research programme between the schools of Engineering and Design to investigate the creation of financial bottom-line Improvements within sustainable product developments, with our focus on Small and Medium Enterprises (SMEs) to give them fresh, competitive advantage in the market.

As part of this research we have created a short survey of which I have attached to this letter, which will enable us to gather the data needed to assist in developing our proposed changes, methods and improvements, to current practices of sustainable development within the SMEs sector. We were hoping that you may be able to assist us in the completion of the form before the start of the Christmas period, or pass on to someone, who also may be able to help within your organisation. The survey should take no longer than 5 minutes to complete and is in the form of multiple choices that allow participants to choose the appropriate response(s). There are 20 questions in total.

All information will be treated with the strictness confidence. The final report will not include details from individual companies. The results will be analysed internally and the general findings will be distributed to all participants. We will be most grateful if you could share your expertise and assist us to take part and we will happily share with you the results and findings once the data has been collected. We are hoping that for those who take part, we will be in a position to give back in return a solid framework for competitive advantage and financial improvement through our final conclusions.
We have provided for you a self addressed and pre-stamped envelope for the return of the survey via post for your convenience.
I would like to take this opportunity in advance to say thank you for your time and efforts, and hope that we will be able to provide you with some tangible benefits and insight through our work here.

Kindest Regards.

Tom Woods

Appendix 1.10: SME Industrial Questionnaire Responses

Below is a sample from the industrial questionnaire SME responses which were returned via post.

SME's & Environmental / Packaging Related Questions.

This Survey should take 5 Minutes to fill out & we will happily share with you the report from this study on completion. Thank you.

Company Name: HAIN TRIDENT FOODS **Industry Sector:** FOOD

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1. What are the current numbers of staff employed within the company? *(please place an 'X' next to the answers)*

   0-9 employees [YES] 10-49 employees [YES] 50-249 employees [YES X]

2. Is the company's gross annual turnover £2 Million or more? *(please place an 'X' next to the answers)* [YES X] [NO]

3. Businesses that use 50 Tonnes or more of Packaging per year are covered by Regulations, Do you know how much Packaging you use by weight, is it over 50 Tonnes? *(please mark 'X')* [YES X] [DONT KNOW] [NO]

4. Of the following, which have you heard of? *(please place an 'X' in the appropriate box)*

   Duty of Care [X] Producer Responsibility (PROR) [X] Packaging Essential Requirements (PER) [X]

5. Which of the following apply to you? *(please place an 'X' next to the answers)*

   Duty of Care [X] Producer Responsibility (PROR) [ ] Packaging Essential Requirements (PER) [X]

6. In terms of managing or enquiring within environmental obligations, what 'external' resources are used to inform or update your knowledge base? *(please briefly specify by placing an 'X' under the name)* **Please leave BLANK if none.**

Federation Small Business	Net-Reg's	Local Authority	Wrap /Envirowise	Business-Link	Trade Association	Consultants
						X

If 'Other', please specify:

7. As a consequence, if using these resources, how effective, beneficial have these been in improving your credentials / knowledge base? **Please rate 1-4 under the name:** 1: Not effective, no Benefit / 2: Limited benefit / 3: Some help / 4: Very Useful

Federation Small Business	Net-Reg's	Local Authority	Wrap /Envirowise	Business-Link	Trade Association	Consultants
	5	1	1	1	2	3

If 'Other', please rate 1-5:

8. Which areas would you say your organisation was competent in, when it comes to dealing with Packaging?

   Please rate 1-3 in each box: 1: No inherent knowledge / 2: Basic understanding, we get by. / 3: Extremely competent, we push boundaries.

Packaging Sustainability	Innovation	Managing Supply Chain	Brand / Marketing	Reducing Carbon	Logistics Efficiency
2	2	2	2	2	2

Reducing Costs	Packaging Re-use Systems	Managing Waste / Recycling	Specifying Needs	Locating new Suppliers
2	1	3	2	2

9. What would be the main factors that would 'encourage' you to take on board / consider new procedures to reduce potential environmental impacts? **Please rate 1-2 in each box:** 1: No, not a priority / 2: Yes, this would be influential to us.

Reduced Costs	Enhanced Brand	Competetiveness	Enviro Concern	Increased Knowledge	Funding	Avoid Fines
2	2	2	2	2	2	2

Consumer Pressure	Supply Chain Pressure	Innovation	Reduced Carbon	Transport Efficiency	Differentiation
2	2	2	2	2	2

10. In addition to any potential obligations towards Regulation, are you currently aware of any Business advantages and benefits for investing resources in moving; 'beyond compliance' with Packaging design?

    (please place an 'X' in the appropriate box) [YES X] [NO] [DONT KNOW]

Please turn over >>

FOOD / SCANNED / 224

11. What would be the main 'barriers' for you to take on board new procedures to reduce environmental impacts?

Please rate 1-2 in each box: 1: No difficulty exists here / 2: This would be a major Factor for us.

Lack of Time	Lack of Internal Resources	Lack of Knowledge	Return on Investment is Unclear	No Supply Chain Pressures
2	2	2	2	2

Lacking Skills	Not in Current Strategy	Stakeholders	Additional Costs	No Clear Benefits	No Interest	No Incentive
2	2	2	2	1	1	1

12. Are you aware of what other companies within your industry are doing, in terms of implementing compliance and reducing environmental impacts?

YES: *(please briefly specify how):*	NO X

13. Where is the current specification and design for your packaging being carried out? *(please place an 'X' next to the answers)*

In House	Consultant / Consultancy X	Off The Shelf / Catalogue X	Packaging Supplier	Retailer / Customer X

14. Which of the folowing criteria are important factors for you, during the specification of your current packaging?

Please rate 1-3 in each box: 1: Not a priority / 2: Interested but we lack the know-how to implement / 3: High Priority, part of current specification.

Material Reduction	Cost Reduction	Logistics and Size	Material Choice	Innovation	Eventual Disposal
3	3	3	3	3	3

Fit For Purpose	Regulation Compliance	Recycling	Reduced Carbon	Marketing	Increased Sales	None
3	3	3	3	3	3	1

15. Do you negotiate with your current suppliers to find the most optimum Packaging Specification to reduce potential Carbon Footprints? **Please rate 1-4 in box:** 1: No, we take what were given / 2:We don't know how/ 3:Rarely / 4:Very Much So [1]

16. Do you engage in discussions with suppliers 'and' customers in relation to fulfilling potential obligations or reducing environmental impacts? **Please rate 1-3 in the box:** 1: Not at All / 2: Only when prompted / 3: Very Much So [2]

17. Are there any processes within your organisation, which monitor the Carbon footprint of your Packaging within the current supply chains, to measure potential environmental impact? *(please mark 'X')* YES | NO X

18. Are there any systems in place which your company use to manage the recycling of Packaging Waste produced?

YES: *(please briefly specify):* ✓ – THROUGH RECYCLING CONTRACTS.
NO: *(please briefly specify why not):*

19. Are any toolkits or frameworks used within your organisation, to assist in implementing sustainability practices to reduce impacts or deal with regulatory Obligations?

YES: *(please briefly specify):* NO	
Advantages:	Disadvantages:

20. Would you happily engage in additional activity 'beyond' your legal compliance in Packaging, if it gave you an additional Business or Marketing advantage, which differentiated you against your competition? *(please mark 'X')* YES X | NO

Thank You for your time.

SME Sector A, 10-49 demonstrate the lowest levels of competence of the four size divisions in relation to the understanding of sustainability know-how at a management level. Responses in relation to each point within Q8, showed a distinct lack of knowledge throughout all areas related to internal sustainability practices. They also show the poorest levels of priority assigned to individual criteria, when specifying packaging design in Q14, due to an overall lack of knowledge to be able to engage within these areas. Specification criteria which were rated of a high priority were simply not reflected by equal levels of competence, which may suggest they place a large amount of faith / responsibility in suppliers and counterparts to adhere to their current levels of ambition.

This sector predominantly relies heavily on the supply chain to deliver their expectations, as none that responded to the industrial questionnaire specified anything in-house, yet their levels of negotiation and collaboration with suppliers and customers throughout, were also the worst of the four sectors. Considering their apparent isolation of involvement during the process of specification and their lack of collaboration, it is hard to consider how SMEs of this size can make sustainable environmental improvements, and influence their supply chain partners to do also.

The apparent lack of collaboration seen here, may well be the catalyst for the poor levels of knowledge demonstrated within the areas of; design for disposal, (a prerequisite of the PER regulations), material choice and material reduction, amongst other areas in Q14. This overall lack of collaboration may additionally be affecting SME supply chain management's, where this sector demonstrated the lowest practical ability to engage effectively. With the lack of tool-kit implementation to assist with any sustainable practices such as the monitoring of carbon, benchmarking their own performances against criteria for improvement may be difficult for this SME size.

The majority are unaware of others companies and what external practices are being employed to aid compliances or reduce environmental impacts, as 100% see no business benefits in moving beyond their compliances. But in comparison they are all 100% positive towards the idea, if a business or marketing advantage can be achieved as a result. This is encouraging as it shows that this sector does have ambitions but they lack the practical knowledge to be able to make effective and sustainable improvements within their organisation.

They share the same barriers as all other SME sectors in that the constraints of; time / internal resources and costs, are a major issue to investing in further environmental improvements. This is adjacent to a rather significant lack in justification to encouraging this sector to move beyond the current environment compliances, due to the fact that they see no clear benefit in attempting to do, as the returns for such investments are currently unknown to them.

They claim that interest, incentive, skills and strategy are not an issue for them, if they can achieve the influential factors of reduced costs, fines, carbon and transport efficiencies. They are inspired by environmental concerns, and potential innovations which may allow them to differentiate themselves against their competition and ultimately become more competitive.

This was the only sector to rate enhanced brand highly as an area of little interest and importance, and only 50% seeing ‘increased knowledge’ and ‘differentiation’ as an influential benefit to them strategically.

Individual SME Profile for Size Division; A, 10-49 Employees			
Q2: Is the company's gross annual turnover £2 Million or more?	Yes	No	
	100%	***none***	
Q3: Do you know how much Packaging you use by weight, is it over 50 Tonnes?	Yes	No	Unsure
	100%	***none***	***none***
Q4: Of the following, which have you heard of?	Duty of Care	PROR	PER
	75%	***62%***	***62%***
Q5: Which of the following apply to you?	Duty of Care	PROR	PER
	62%	***62%***	***62%***
Q8: Which areas are you competent in, when it comes to dealing with Packaging?	No	A Basic Level	Competent
Packaging Sustainability	***37%***	***38%***	***25%***
Innovation	***37%***	***50%***	***13%***
Managing Supply Chain	***37%***	***38%***	***25%***
Brand / Marketing	***25%***	***62%***	***13%***
Reducing Carbon	***62%***	***38%***	***None***
Logistics Efficiency	***37%***	***38%***	***25%***
Reducing Costs	***23%***	***62%***	***13%***
Packaging Re-use Systems	***37%***	***38%***	***25%***
Managing Waste / Recycling	***None***	***62%***	***38%***
Specifying Needs	***50%***	***50%***	***None***
Locating new Suppliers	***25%***	***62%***	***13%***
Q9: What would 'encourage' you to take on board new procedures to reduce Environmental	Not a Priority	Yes,	
Reduced Costs	***12%***	***88%***	
Enhanced Brand	***87%***	***13%***	
Competitiveness	***37%***	***63%***	
Enviro Concern	***37%***	***63%***	
Increased Knowledge	***50%***	***50%***	
Funding	***50%***	***50%***	
Avoid Fines	***25%***	***75%***	
Consumer Pressure	***25%***	***75%***	
Supply Chain Pressure	***50%***	***50%***	
Innovation	***25%***	***75%***	
Reduced Carbon	***37%***	***63%***	
Transport Efficiency	***25%***	***75%***	
Differentiation	***50%***	***50%***	
Q10: In addition to Regulations, are you aware of any Business benefits for moving; beyond	Yes	No	
	none	***100%***	
Q11: What would be the main 'barriers' for you to take on board new procedures to reduce Enviro impacts?	No Difficulty	Major	
Lack of Time	***37%***	***63%***	
Lack of Internal Resources	***37%***	***63%***	
Lack of Knowledge	***37%***	***63%***	
Return on Investment is Unclear	***25%***	***75%***	
No Supply Chain Pressures	***75%***	***25%***	
Lacking Skills	***75%***	***25%***	
Not in Current Strategy	***87%***	***13%***	
Stakeholders	***87%***	***13%***	
Additional Costs	***25%***	***75%***	
No Clear Benefits	***25%***	***75%***	
No Interest	***75%***	***25%***	
No Incentive	***62%***	***38%***	
Q12: Are you aware of other companies and their procedures to reduce environmental	Yes	No	
	37%	***63%***	
Q14: Which are important factors for you, during the specification of your current	Not a Priority	Lack	High
Material Reduction	***38%***	***50%***	***12%***
Cost Reduction	***None***	***25%***	***75%***
Logistics and Size	***12%***	***50%***	***38%***
Material Choice	***13%***	***50%***	***37%***
Innovation	***37%***	***37%***	***25%***
Eventual Disposal	***62%***	***25%***	***12%***
Fit For Purpose	***25%***	***None***	***75%***
Regulation Compliance	***12%***	***12%***	***75%***
Recycling	***12%***	***25%***	***63%***
Reduced Carbon	***37%***	***13%***	***50%***
Marketing	***25%***	***25%***	***50%***
Increased Sales	***25%***	***none***	***75%***
Q15: Do you negotiate with suppliers to find the most optimum Specification to reduce Carbon	No	Dont know	Rarely / Yes
	25%	***12%***	***37% / 25%***
Q16: Do you engage with suppliers & customers in fulfilling obligations or reducing environmental	No	Only if	Very much
	12%	***88%***	***none***
Q17: Are there any processes, which monitor the Carbon footprint of your Packaging within supply	Yes	No	
	25%	***75%***	
Q18: Are there any systems in place to manage the recycling of Packaging Waste produced?	Yes	No	
	75%	***25%***	
Q19: Are Toolkits used to assist in sustainability practices for reducing impact or handle Reg's &	Yes	No	
	50%	***50%***	
Q20: Engage in additional activity 'beyond' compliances, if it gave you Business or Marketing advantages?	Yes	No	
	100%	***none***	

Showing responses to the industrial questionnaire from 10 to 49 SMEs.

SME Sector B, 50-99 employees boasts the highest levels of competence for environmental management, of all SME sizes, considering that this division is only the second largest in all four categories. Some companies here do design in-house as opposed to none within the previous SME size category, but the majority is generally spread throughout the supply chain during packaging specifications. They have a slightly higher level of collaboration with their packaging suppliers in comparison to the previous sector, but there is still no strong evidence of computer systems being used to manage environmental practices, being that 100% of this sector answered no to the use of tool-kits.

The majority of this sector demonstrates no awareness towards the practices of other companies, or what external activities may currently be implemented to aid compliances or reduce environmental impacts. Yet again the majority response to the industrial questionnaire see no business benefits in moving beyond their compliances, but the majority are still positive towards the idea, if a business or marketing advantage can be achieved as a result. This is synonymous with the response from the smallest SME sector which additionally voiced also, that they too see no business benefit in moving beyond compliances, but welcomed the prospect if rewards could be obtained from the investment.

They share the same barriers as all other sectors in that additional ‘time / internal resources and costs’ are a major issue, beside a lack of knowledge towards moving beyond their compliances. They currently see no clear benefit in attempting to do so as the return is currently unknown to them.

They claim that interest, incentive, skills and strategy are not an issue for them, if they can achieve the influential factors of; reduced costs, fines, carbon and transport efficiencies.

Individual SME Profile for Size Division; B, 50-99 Employees			
Q2: Is the company's gross annual turnover £2 Million or more?	Yes	No	
	100%		
Q3: Do you know how much Packaging you use by weight, is it over 50 Tonnes?	Yes	No	Unsure
	100%		
Q4: Of the following, which have you heard of?	Duty of	PROR	PER
	91%	***73%***	***55%***
Q5: Which of the following apply to you?	Duty of	PROR	PER
	64%	***73%***	***45%***
Q8: Which areas are you competent in, when it comes to dealing with Packaging?	No	A Basic Level	Compet
Packaging Sustainability	***18%***	***55%***	***27%***
Innovation	***18%***	***45%***	***27%***
Managing Supply Chain	***none***	***45%***	***55%***
Brand / Marketing	***27%***	***37%***	***36%***
Reducing Carbon	***28%***	***45%***	***27%***
Logistics Efficiency	***27%***	***37%***	***36%***
Reducing Costs	***18%***	***27%***	***55%***
Packaging Re-use Systems	***45%***	***55%***	***none***
Managing Waste / Recycling	***9%***	***27%***	***64%***
Specifying Needs	***none***	***45%***	***55%***
Locating new Suppliers	***9%***	***36%***	***55%***
Q9: What would 'encourage' you to take on board new procedures to reduce Environmental Impacts?	Not	Yes,	
Reduced Costs	***none***	***100%***	
Enhanced Brand	***27%***	***73%***	
Competitiveness	***18%***	***82%***	
Enviro Concern	***18%***	***82%***	
Increased Knowledge	***64%***	***36%***	
Funding	***54%***	***46%***	
Avoid Fines	***36%***	***64%***	
Consumer Pressure	***18%***	***82%***	
Supply Chain Pressure	***64%***	***36%***	
Innovation	***36%***	***64%***	
Reduced Carbon	***18%***	***82%***	
Transport Efficiency	***9%***	***91%***	
Differentiation	***55%***	***45%***	
Q10: In addition to Regulations, are you aware of any Business benefits for moving; beyond compliances?	Yes	No	
	18%	***82%***	
Q11: What would be the main 'barriers' for you to take on board new procedures to reduce Enviro impacts?	No	Major Factor	
Lack of Time	***27%***	***73%***	
Lack of Internal Resources	***37%***	***63%***	
Lack of Knowledge	***46%***	***54%***	
Return on Investment is Unclear	***25%***	***75%***	
No Supply Chain Pressures	***82%***	***18%***	
Lacking Skills	***73%***	***27%***	
Not in Current Strategy	***73%***	***27%***	
Stakeholders	***91%***	***9%***	
Additional Costs	***9%***	***91%***	
No Clear Benefits	***18%***	***82%***	
No Interest	***82%***	***18%***	
No Incentive	***64%***	***36%***	
Q12: Are you aware of other companies and their procedures to reduce environmental impacts?	Yes	No	
	27%	***73%***	
Q14: Which are important factors for you, during the specification of your current packaging?	Not	Lack	Priority
Material Reduction	***9%***	***9%***	***82%***
Cost Reduction	***9%***	***none***	***91%***
Logistics and Size	***37%***	***27%***	***36%***
Material Choice	***45%***	***32%***	***36%***
Innovation	***37%***	***27%***	***36%***
Eventual Disposal	***46%***	***27%***	***27%***
Fit For Purpose	***none***	***27%***	***73%***
Regulation Compliance	***18%***	***18%***	***64%***
Recycling	***27%***	***27%***	***46%***
Reduced Carbon	***37%***	***27%***	***36%***
Marketing	***27%***	***27%***	***46%***
Increased Sales	***27%***	***none***	***73%***
Q15: Do you negotiate with suppliers to find the most optimum Specification to reduce Carbon Footprints?	No	Dont know	Rare / Yes
	18%	***9%***	***36% / 36%***
Q16: Do you engage with suppliers & customers in fulfilling obligations or reducing environmental impacts?	No	Only if	Very
	18%	***36%***	***45%***
Q17: Are there any processes, which monitor the Carbon footprint of your Packaging within supply chains?	Yes	No	
	27%	***73%***	
Q18: Are there any systems in place to manage the recycling of Packaging Waste produced?	Yes	No	
	81%	***19%***	
Q19: Are Toolkits used to assist in sustainability practices for reducing impact or handle Reg's & Obligations?	Yes	No	
	none	***100%***	
Q20: Engage in additional activity 'beyond' compliances, if it gave you Business or Marketing advantages?	Yes	No	
	63%	***37%***	

Table 5.5: Showing responses to the industrial questionnaire from 50 to 99 SMEs.

They are inspired by environmental concerns, potential innovations and brand which may allow them to differentiate themselves against their competition and ultimately become more competitive. Over 55% of this sector also rated that 'increased knowledge' and 'differentiation' was not an influential benefit to them strategically. 87% of this sector see the importance of 'consumer pressure' as being influential to encourage them to take on new procedures, the highest of all four sectors, but also the 'lowest' of all four in recognising any pressures within the supply chain as significant.

SME Sector C, 100-199 employees demonstrated an overall drop with environmental management competency, pitched against a higher priority placed on environmental specification criteria. Specification practices with external partners are the most intricate of all the four sectors in operation, demonstrating a broad mix of packaging suppliers, consultants and in-house design teams during Packaging specification. Unsurprisingly, collaboration with suppliers and customers is the highest of all the four sectors, (but, only reaching only a modest 45% at best). Of those companies who demonstrate proficiency in collaboration with consultants and packaging suppliers, 80% of these companies also responded to understanding the advantages and business benefits in moving beyond compliances, whereas others sectors simply do not.

The SMEs within this sector who responded to being able to identify a business benefit to move beyond their compliances, are also the exact same SMEs which responded to being aware of other companies and the practices which they currently implement to reduce their environmental impacts. This was the only sector of the four size divisions to demonstrate any awareness of other organisations and their environmental practices. This shows that there is a sudden change in trend here where organisations are looking outside of their own practices at the behaviours of other

organisations. At this stage it is impossible to tell if the reason SMEs are observing other organisations, is because they understand there are business benefits to be attained, or whether it is vice versa, but it seems apparent that this percentage are aware of something that others are not.

This sector also rated highly in the barriers section of the survey, that 'lacking in knowledge' was not an issue for them when considering procedures to move beyond compliances, whereas all other SME sectors were in opposition to this point of view. The majority here are in fact uniquely aware of others companies and what external practices are being employed to aid compliances or reduce environmental impacts, the only sector of the four to demonstrate this. They see business benefits in moving beyond their compliances, and they are all 'positive towards the idea' of further improvements, if a business or marketing advantage can be achieved as a result of the investment. They share the same barriers as all other sectors in that additional 'time / internal resources and costs' are an issue including the only sector to rate 100% of stakeholders being an issue as a barrier to move beyond their compliances. This issue with stakeholders may also represent the fact that this sector is also the most intricate in packaging specification processes, with numerous parties involved and therefore numerous interests. They are the only sector to claim that knowledge is not an issue to moving beyond their compliances, as oppose to all other, who rated this as a significant barrier. They claim that interest, incentive, skills, lack of knowledge and strategy are not an issue for them, if they can achieve the influential factors of reduced costs, fines, carbon and transport efficiencies.

They are inspired by environmental concerns, potential innovations, increased knowledge and brand which may allow them to differentiate themselves against their competition and ultimately become more competitive, also rated highly as influential.

Individual SME Profile for Size Division; C, 100-199 Employees				
Q2: Is the company's gross annual turnover £2 Million or more?	Yes	No		
	100%			
Q3: Do you know how much Packaging you use by weight, is it over 50 Tonnes?	Yes	No	Unsure	
	100%			
Q4: Of the following, which have you heard of?	Duty of Care	PROR	PER	
	72%	***63%***	***36%***	
Q5: Which of the following apply to you?	Duty of Care	PROR	PER	
	72%	***63%***	***18%***	
Q8: Which areas are you competent in, when it comes to dealing with Packaging?	No	A Basic Level	Competent	
Packaging Sustainability	***20%***	***72%***	***8%***	
Innovation	***19%***	***54%***	***27%***	
Managing Supply Chain	***20%***	***27%***	***54%***	
Brand / Marketing	***37%***	***45%***	***18%***	
Reducing Carbon	***45%***	***45%***	***9%***	
Logistics Efficiency	***20%***	***45%***	***36%***	
Reducing Costs	***10%***	***36%***	***54%***	
Packaging Re-use Systems	***63%***	***18%***	***none***	
Managing Waste / Recycling	***19%***	***18%***	***63%***	
Specifying Needs	***20%***	***36%***	***45%***	
Locating new Suppliers	***17%***	***18%***	***63%***	
Q9: What would 'encourage' you to take on board new procedures to reduce	Not a	Yes, Influential		
Reduced Costs	***none***	***100%***		
Enhanced Brand	***37%***	***63%***		
Competitiveness	***10%***	***90%***		
Enviro Concern	***18%***	***72%***		
Increased Knowledge	***37%***	***63%***		
Funding	***37%***	***63%***		
Avoid Fines	***37%***	***63%***		
Consumer Pressure	***46%***	***54%***		
Supply Chain Pressure	***18%***	***72%***		
Innovation	***18%***	***72%***		
Reduced Carbon	***55%***	***45%***		
Transport Efficiency	***19%***	***81%***		
Differentiation	***37%***	***63%***		
Q10: In addition to Regulations, are you aware of any Business benefits for moving;	Yes	No		
	54%	***46%***		
Q11: What would be the main 'barriers' for you to take on board new procedures to	No Difficulty	Major Factor		
Lack of Time	***54%***	***46%***		
Lack of Internal Resources	***37%***	***63%***		
Lack of Knowledge	***72%***	***28%***		
Return on Investment is Unclear	***54%***	***46%***		
No Supply Chain Pressures	***63%***	***37%***		
Lacking Skills	***72%***	***28%***		
Not in Current Strategy	***90%***	***10%***		
Stakeholders	***none***	***100%***		
Additional Costs	***28%***	***72%***		
No Clear Benefits	***37%***	***63%***		
No Interest	***90%***	***10%***		
No Incentive	***63%***	***37%***		
Q12: Are you aware of other companies and their procedures to reduce	Yes	No		
	54%	***46%***		
Q14: Which are important factors for you, during the specification of your current	Not a	Lack	High Priority	
Material Reduction	***18%***	***9%***	***72%***	
Cost Reduction	***none***	***none***	***100%***	
Logistics and Size	***36%***	***10%***	***54%***	
Material Choice	***10%***	***27%***	***72%***	
Innovation	***10%***	***36%***	***54%***	
Eventual Disposal	***19%***	***45%***	***36%***	
Fit For Purpose	***9%***	***none***	***91%***	
Regulation Compliance	***18%***	***none***	***82%***	
Recycling	***18%***	***19%***	***63%***	
Reduced Carbon	***36%***	***37%***	***27%***	
Marketing	***45%***	***19%***	***36%***	
Increased Sales	***10%***	***18%***	***72%***	
Q15: Do you negotiate with suppliers to find the most optimum Specification to reduce	No	Dont know	Rarely	Always
	27%	***none***	***27%***	***45%***
Q16: Do you engage with suppliers & customers in fulfilling obligations or reducing	No	Only if Prompted	Very much	
	none	***54%***	***45%***	
Q17: Are there any processes, which monitor the Carbon footprint of your Packaging	Yes	No		
	28%	***72%***		
Q18: Are there any systems in place to manage the recycling of Packaging Waste	Yes	No		
	100%	***none***		
Q19: Are Toolkits used to assist in sustainability practices for reducing impact or handle Reg's	Yes	No		
	54%	***46%***		
Q20: Engage in additional activity 'beyond' compliances, if it gave you Business or	Yes	No		
	81%	***19%***		

Showing responses to the industrial questionnaire from 100 to 199 SMEs.

SME Sector D, 200-250. Although being the largest out of all of the four sizes, sector D, 200-250 employees has a significantly sharp decline in regards to the management competence of internal environmental practices. In parallel to this there is an equally steep increase in regards to basic knowledge applied within these practices. It has become clear that as the size of the SME organisation has increased, the general competency in managing environmental criteria has declined and basic knowledge has become more common, showing that size is not always indicative of proficiency.

This sector places the highest amount of priority on packaging specification criteria than any of the other three SME sector sizes. Even though the level of collaboration and negotiation with packaging suppliers and others within the supply chain is not particularly high, they so far appear to promote best practice in relation to the scope of packaging specification areas, raised within the industrial questionnaire. This sector additionally has the highest levels of tool kit implementation than any other sector for the management of carbon efficiency and waste management systems.

This SME size also stands out against the others as having the largest number of internal barriers to overcome for sustainability improvements, than any other sector which responded in relation to Q11. This sector did not only respond with the highest volume of barriers, but also demonstrated the highest volume of overall percentages for each these individual points raised, with a majority demonstrating 100% in response.

Adjacent to the barriers for improvement which this sector size faces, this sector also demonstrates the highest responses in relation to areas that would be encouraging to take on board new environmental procedures. This is the only sector to rate highly that it lacks the skills to engage in new procedures for sustainable developments, and the only sector to rate highly that building new procedures in and around current strategies

would be a major difficulty. This may be due to the fact that organisations of this size employ a significant number of middle managers, although the overall resources may be greater the levels of decision-making which would need to involve multiple levels of management for change, may ultimately be restrictive. Therefore even though large organisations may demonstrate more divisions, each division may essentially be less specialised than say a smaller company with less resources, but which ultimately has more responsibility placed upon specialised individuals.

In summary, the majority of this sector was unaware of related companies and what external practices are being employed to aid regulation compliance or reduce environmental impacts. Also the majority see 'no' business benefits in moving beyond their compliances but a 'slightly lesser' majority are relatively 'positive towards the idea', if a business or marketing advantage can be achieved as a result. They have the highest number of barriers to implementing new procedures for reducing environmental impacts, including; additional costs, lack of time, lack of resources, lack of knowledge, lack of skills and supply chain pressures. They are the only sector of the four to claim that supply chain pressure is an issue and the only sector to claim that merging changes amongst current strategy would also be a problem. Alongside this, the highest percentage of all four sectors at 87% see no clear benefit in attempting to improve their environmental credentials, and 100% of this sector, also respond that currently the return is unclear to them. They claim that interest and incentive is not an issue for them, if they can achieve the influential factors of reduced costs, fines, carbon, and transport efficiencies.

They are inspired by environmental concerns, potential innovations, increased knowledge and brand which may allow them to differentiate themselves against their competition, and ultimately become more competitive.

Individual SME Profile for Size Division; D, 200-250 Employees				
Q2: Is the company's gross annual turnover £2 Million or more?	Yes	No		
	100%			
Q3: Do you know how much Packaging you use by weight, is it over 50 Tonnes?	Yes	No	Unsure	
	100%			
Q4: Of the following, which have you heard of?	Duty of Care	PROR	PER	
	87%	***75%***	***62%***	
Q5: Which of the following apply to you?	Duty of Care	PROR	PER	
	87%	***62%***	***62%***	
Q8: Which areas are you competent in, when it comes to dealing with Packaging?	No	A Basic Level	Competent	
Packaging Sustainability	***25%***	***50%***	***25%***	
Innovation	***25%***	***75%***	***none***	
Managing Supply Chain	***none***	***63%***	***37%***	
Brand / Marketing	***13%***	***50%***	***37%***	
Reducing Carbon	***none***	***88%***	***12%***	
Logistics Efficiency	***none***	***63%***	***37%***	
Reducing Costs	***none***	***88%***	***12%***	
Packaging Re-use Systems	***62%***	***26%***	***12%***	
Managing Waste / Recycling	***none***	***63%***	***37%***	
Specifying Needs	***none***	***75%***	***25%***	
Locating new Suppliers	***none***	***63%***	***37%***	
Q9: What would 'encourage' you to take on board new procedures to reduce	Not a	Yes, Influential		
Reduced Costs	***none***	***100%***		
Enhanced Brand	***25%***	***75%***		
Competitiveness	***25%***	***75%***		
Enviro Concern	***none***	***100%***		
Increased Knowledge	***38%***	***62%***		
Funding	***50%***	***50%***		
Avoid Fines	***38%***	***62%***		
Consumer Pressure	***25%***	***75%***		
Supply Chain Pressure	***25%***	***75%***		
Innovation	***25%***	***75%***		
Reduced Carbon	***13%***	***87%***		
Transport Efficiency	***none***	***100%***		
Differentiation	***38%***	***62%***		
Q10: In addition to Regulations, are you aware of any Business benefits for moving;	Yes	No		
	38%	***62%***		
Q11: What would be the main 'barriers' for you to take on board new procedures to	No Difficulty	Major Factor		
Lack of Time	***none***	***100%***		
Lack of Internal Resources	***13%***	***87%***		
Lack of Knowledge	***25%***	***75%***		
Return on Investment is Unclear	***none***	***100%***		
No Supply Chain Pressures	***38%***	***62%***		
Lacking Skills	***25%***	***75%***		
Not in Current Strategy	***25%***	***75%***		
Stakeholders	***50%***	***50%***		
Additional Costs	***none***	***100%***		
No Clear Benefits	***13%***	***87%***		
No Interest	***75%***	***25%***		
No Incentive	***62%***	***38%***		
Q12: Are you aware of other companies and their procedures to reduce	Yes	No		
	25%	***75%***		
Q14: Which are important factors for you, during the specification of your current	Not a	Lack	High Priority	
Material Reduction	***none***	***25%***	***75%***	
Cost Reduction	***none***	***none***	***100%***	
Logistics and Size	***none***	***38%***	***62%***	
Material Choice	***13%***	***25%***	***62%***	
Innovation	***13%***	***37%***	***50%***	
Eventual Disposal	***13%***	***25%***	***62%***	
Fit For Purpose	***none***	***13%***	***87%***	
Regulation Compliance	***none***	***25%***	***75%***	
Recycling	***none***	***25%***	***75%***	
Reduced Carbon	***none***	***38%***	***62%***	
Marketing	***37%***	***13%***	***50%***	
Increased Sales	***13%***	***37%***	***50%***	
Q15: Do you negotiate with suppliers to find the most optimum Specification to reduce	No	Dont know	Rarely	Always
	50%	***none***	***12%***	***37%***
Q16: Do you engage with suppliers & customers in fulfilling obligations or reducing	No	Only if Prompted	Very much	
	none	***62%***	***37%***	
Q17: Are there any processes, which monitor the Carbon footprint of your Packaging	Yes	No		
	50%	***50%***		
Q18: Are there any systems in place to manage the recycling of Packaging Waste	Yes	No		
	100%	***none***		
Q19: Are Toolkits used to assist in sustainability practices for reducing impact or handle Reg's	Yes	No		
	62%	***38%***		
Q20: Engage in additional activity 'beyond' compliances, if it gave you Business or	Yes	No		
	62%	***38%***		

Showing responses to the industrial questionnaire from 200 to 250 SMEs.

PACKAGING SUPPLIERS. A reflective set of questions was sent out to the *Packaging Suppliers,* to create a closed loop of investigation in order to cross-compare the pro-activeness and engagements between both parties, in relation to regulatory procedures and reducing environmental impacts within the SME community.

When suppliers were asked within the supplier survey of the SMEs ability to specify their own requirements, the overall response was that SME competence was rated at; a *poor and sporadic* level, when engaging with suppliers and packaging procedures. This reflects the previous opinions from collaborations with the external panel, who stated that SMEs lack 'clout' when making informed and critical decisions. 85% of suppliers shared this opinion of SMEs being at a *poor and sporadic* level of engagement when dealing with 'Packaging Sustainability', and an equally high 80% of supplier respondents rated that SMEs struggle when engaging with Regulatory compliances.

When asked of how often SMEs prompt into negotiations with specific goals for environmental objectives in Q12, only 7% of packaging suppliers rated that any initiation takes place from the side of the SME. With previous research taken into consideration, overall this indicates there is a significant lack of engagement on behalf of the SME, towards pursuing sustainable and environmental improvements.

As previously mentioned, SMEs appear to place a considerable amount of responsibility and trust upon their suppliers to meet packaging specification criteria, considering that overall the levels of communication and negotiation between both parties are lacking. In the current packaging supplier survey, when suppliers were asked if they themselves negotiated with SMEs to find the most optimum packaging specifications to reduce carbon emissions, 60% responded that they *rarely* did this,

and 53% responded that they only collaborate with SMEs to reduce environmental impacts when they were *prompted* to do so, (Q11, Q17).

This now appears to present a blockage in best practice between both the SME when outlining specification criteria for suppliers, and suppliers engaging with SMEs to improve overall performance. SME data showed 'collaboration' in regards to reducing environmental impacts is currently lacking on behalf of the SME, with supplier data now confirming and supporting this proposition. But, suppliers also responded that they themselves don't particularly engage with SMEs either, due to the SMEs overall lack of intrinsic knowledge to be able to engage. This therefore demonstrates that improved systems of communication are required from one side or the other at present, if improvements towards environmental best practices are to be attainable at an SME level.

In relation to where priority is placed during specifications, 'cost reduction' came out top at 90% *standard priority*, closely followed by 'fitness for purpose', 'material choice' and 'material reduction'. The criteria here for decision making appears to be more in line with financial concerns rather than environmental, where following data showed that 77% of respondent suppliers rated that 'eventual disposal' and 'reducing carbon', is a *non-priority* for them, when providing packaging on behalf of client requests. Additionally, 55% of suppliers also rated that 'regulation compliance' and 'recycling' are equally, and surprisingly, a *non-priority* for them when providing packaging on behalf of client requests. 68% of suppliers also responded that they *do not* employ any systems internally, to measure the carbon footprint of their products placed upon the market. Where there are basic requirements placed upon the SME product producers to meet packaging regulations and waste reduction targets, it is difficult to see how these systems can be effectively managed, when neither party either requests or offers proficiency for compliance.

When suppliers were asked to demonstrate their own levels of competence when working with SMEs; ‘reducing costs’, ‘innovation’ and ‘understanding current needs of SMEs’ came out top at around 64% equally, but in stark contrast, the worst response was reserved to the ‘reducing of carbon’, where 74% rated themselves with only a *basic level* of current understanding in this area.

When considering regulatory obligations towards packaging design on behalf of the SME, it was surprising to find that only 60% of supplier respondents are actually aware of the PROR packaging regulations that apply to all those who place packaging on the market, including packaging suppliers. This worsened with the PER regulations, where 56% felt that is was not their responsibility manage this responsibility, putting considerable pressure back upon the SMEs to adhere to these specific legal requirements through their specifications.

This is not to say though that improvements cannot be made, as 92% responded that they would potentially move beyond their legal current compliances, if doing so gave them a business or marketing *advantage* for the investment. What this appears to come down to again is communication within supply chains, communication of the potential sustainability benefits, and the lack of knowledge towards any known advantages in pushing for impact reduction, with a justifiable case for doing so where the numbers add up strategically.

We also see that a high percentage of 79% of respondents have no awareness of other processes or advancements in which other organisations may be implementing for environmental improvement. In repetition of SME data results, suppliers also responded that; the ‘return is unclear’, ‘no clear benefits’ and ‘additional costs’, are the major barriers which restrict them in working closer with SMEs to assist in developing beyond compliant packaging solutions.

Packaging Suppliers Profile; when working with current UK SMEs			
Q4: Which of the following apply to you?	Duty of Care	PROR	PER
	28%	***60%***	***46%***
Q7: Which areas are you competent in, when it comes to working with prospective SME clients?	No	Basic level	Competent
Packaging Sustainability	***8%***	***32%***	***60%***
Innovation	***3%***	***29%***	***68%***
Sustainable Supply Chain Managament	***7%***	***42%***	***42%***
Brand / Marketing	***3%***	***60%***	***32%***
Reducing Carbon	***19%***	***74%***	***7%***
Logistics Efficiency	***14%***	***43%***	***39%***
Reducing Costs	***3%***	***35%***	***57%***
Packaging Re-use Systems	***21%***	***46%***	***28%***
Managing Waste / Recycling	***7%***	***21%***	***67%***
Understanding SMEs Needs	***5%***	***35%***	***60%***
Expanding Product R&D	***21%***	***42%***	***32%***
Q8: During packaging specification, do you communicate any technical data, in relation to Regulations?	Yes	No	
	78%	***22%***	
Q9: How would you rate on average, the ability of an SME, to specify their requirements in terms of;	Poor	Sporadic	Consistent
Packaging Sustainability	***36%***	***46%***	***14%***
Regulatory Compliances	***36%***	***43%***	***17%***
Q10: In addition to Regulations, are you aware of any Business benefits for moving; beyond compliances?	Yes	No	
	50%	***50%***	
Q11: When working with SMEs, do you assist with their understanding of Regulations and compliances?	It's their Job	Prompted	Very
	14%	***53%***	***32%***
Q12: When working with SMEs, how often do they prompt you into discussions around optimising packaging to any specific environmental goals and strategic objectives?	Not at ALL	Odd	Prompt / YES
	14%	***46%***	***32% / 7%***
Q13: What are the main 'barriers' to working closer with SMEs, for developing beyond compliance packagings?	No Difficulty	Major	
Lack of Time	***57%***	***43%***	
Lack of Internal Resources	***60%***	***40%***	
SMEs Lack Appropriate Knowledge	***32%***	***68%***	
Return on Investment is Unclear	***32%***	***68%***	
No Supply Chain Pressures	***74%***	***36%***	
Lacking Skills	***71%***	***29%***	
Not in Current Strategy	***53%***	***47%***	
Stakeholders	***68%***	***32%***	
Additional Costs	***42%***	***58%***	
No Clear Benefits	***50%***	***50%***	
No Interest	***60%***	***40%***	
No Incentive	***57%***	***43%***	
Q14: Are you aware of other companies within your industry, working to assist SMEs with reducing impacts by driving new packaging innovations, on their behalf?	Yes	No	
	21%	***81%***	
Q16: Which are important factors for you, during the determination of current SME packaging?	Not a Priority	if Prompted	Standard
Material Reduction	***3%***	***24%***	***71%***
Cost Reduction	***none***	***10%***	***81%***
Logistics and Size	***7%***	***28%***	***64%***
Material Choice	***3%***	***14%***	***82%***
New Innovations	***4%***	***21%***	***57%***
Eventual Disposals	***35%***	***42%***	***21%***
Fit For Purpose	***10%***	***3%***	***85%***
Regulation Compliance	***14%***	***35%***	***50%***
Recycling	***14%***	***40%***	***46%***
Reduced Carbon	***40%***	***25%***	***35%***
Marketing	***32%***	***40%***	***28%***
Pushing Stock	***32%***	***43%***	***25%***
Time	***18%***	***32%***	***50%***
Q17: Do you negotiate with SMEs to find the most optimum Specification to reduce Carbon Footprints?	No; 'Stock'	Minor	Very
	14%	***60%***	***25%***
Q18: Do you engage with suppliers & SME customers in fulfilling obligations or reducing environmental impacts?	No	if Prompted	Very
	3%	***49%***	***49%***
Q19: Are there any processes, which monitor the Carbon footprint of your Packaging within supply	Yes	No	
	32%	***68%***	
Q20: Are there any systems in place to manage the recycling of Packaging Waste produced?	Yes	No	
	89%	***11%***	
Q21: Are Toolkits used to assist in sustainability practices for reducing impact or handle Reg's & Obligations?	Yes	No	
	40%	***60%***	
Q22: Engage in additional activity 'beyond' compliances, if it gave you Business or Marketing advantages?	Yes	No	
	92%	***8%***	

Responses to the industrial questionnaire from Packaging Suppliers.

Additionally we can observe that 68% are potentially dissuaded from working closely with SMEs because they believe that SMEs lack the appropriate knowledge to engage

with them. Even though suppliers state that; ‘interest, skills, time and resources’ are not a restrictive factor internally.

This presents a situation where SMEs are not attempting to push their boundaries, due to a lack in knowledge of ‘where’ to push and uncertainty of what returns may result. Suppliers have the knowledge time and skills, but don’t seem to wish to engage with SMEs, as they believe the prerequisite knowledge base is not there as a foundation, resulting in less communication.

Where either side does not engage, it provides little room for improvement and the breaking out of current stalemates of practice. One side or the other needs to begin taking steps to open up discussion in regards to environmental improvements, which are both strategically beneficial and worthwhile, to both parties involved.

Appendix 1.11: Final Delphi Panel Evaluations

Below are samples from the Delphi panel evaluations: Postal and Transcripts.

PARTICIPANT A1 PHONE TRANSCRIPT

A1: [redacted]. I have a couple of comments for you, the average SME I know would find this a little bit complex to be honest. For example the information which is embedded within the map, such as ISO 14,001, etc etc, in my experience there is a lawful lot of SMEs that wouldn't have a clue what that is about. So when you're setting this up you need to think about providing additional sources of information for that.

Tom: so do you think with the way things are at the moment, they need some kind of introductory material in complement with the mapping process?

A1: [redacted] yes I think so, I will think that you will need a kind of bluffers guide to how to use this thing. The most fundamental problem that I have with it is, where is the product? I have been a packaging man for 46 years now in this industry, and have run a few companies etc, and the first in new have got to do is develop a product. Now to me with this map, it doesn't appear to be developing a product until phase four. So for me the start point is working out what products we have and then understanding that it has a primary pack, that would be the start point for me, in terms of any thinking in relation to what I'm going to do with the map. It has to be said that the environmental impact product is 10 times the environmental impact of the package, so that is really where the first thought needs to go into. I don't see any reason why you should tailor this system to cater for both product and product packaging. Now when I looked at the first thing being reused systems and closedloop, we haven't even defined the product nor the product primary packaging, (Tom, maybe we need something here which looks into the options of primary and tertiary packaging providing different options in a refined version of the map) and we are already talking about containers which stack collapse. It's jumping ahead of the gun pretty much so, in my view, so that SMEs are going to look at this model and say, where is my product and where is my initial pack? (I think really this is being defined within the early phases of NPD on the map, maybe just is not clear enough). I think therefore what you have as phase four needs to be very much earlier and the first action point, because once you have your product defined and start to select packaging, (and by the way fit for purpose design needs to be top of the list, so we can work out is this packaging actually going to work) then the steps in the map can guide you into the relevant processes. (But we do not need to be considering these early on in the process, Tom)

Tom: we wanted the map to be used as a prompting system for the SME, so they can understand how all these factors relate to NPD, give them away asking more informed questions, do you think the map holds value with this?

A1: [redacted] I think it does, I think it breaks all of the processes down very well, I think there is a significant omission with the primary pack which needs to be in there somewhere, and I couldn't find it to be honest with you, and I think you're running order needs to be re-looked at. A lot of things which SMEs do tend to be intuitive, it's not your

corporate structured type of environment, somebody comes up with a good idea and the think to themselves what the hell do I do now? So it is the what the hell do I do now question which I think is very important, and what you need to consider when putting this map together. I mean all the things inside the map very important and some of them are obvious but that doesn't matter because it's pretty comprehensive, but it's got to be logical, and I'm really struggling at the moment, and when I sat down and looked at it this morning I thought where is the product where is the start point? For example transport efficiencies come way down in the list, certainly not within phase 2 and phase 3. Start with the product start with the primary pack, and then look at the order of things, such as primary secondary and tertiary.

Tom: do you think there is value in trying to get SMEs to consider for example, transport efficiencies much earlier on in the process at the design stage, so they have an idea where they would like to be later on?

A1: [redacted]: I think that is value in it Tom, I just question to what extent they would take any notice of that to be honest with you stop, I think there is a world of difference between what is nice to have and what is necessary to have. I think the primary consideration for SMEs is deciding what the product is and the initial packaging which makes it look good. I think you need to consider the order in which the operations happen as packaging is usually developed alongside the product as the project moves forwards, issues like transport efficiencies and secondary tertiary packaging are important, but they will become more important as the project develops.

Tom: do you think that the map helps SME push the bridges of communication, by getting them to ask more informative questions with their suppliers, and help them in this way?

A1: [redacted]: yes I think it does, I think it is a very good and comprehensive checklist as there is an awful lot in their, I think you need to work to make it sufficiently user-friendly for the SMEs, but I think that once they have that grounding, and one point that I think you're absolutely right on, if they then talk to their suppliers, and they talk about some of the things contained within this map, the suppliers will most likely not try and pull the wool over their eyes, because the SMEs have some level of knowledge.

PARTICIPANT B1

Tom: do you think that this method of mapping sustainability is useful for SMEs to prompt them in the right direction?

B1 [redacted]: yes I think it's useful in that way, but I also think it is useful in putting everything together, otherwise the information in regards to sustainability can be very disparate, so putting it together in this manner makes a very good checklist.

Tom: do you think that this system could work as an online overall framework, that both the regulators could use and the SMEs could use at the same time, to disseminate and receive information in regards to sustainable procedures?

B1 [redacted]: I think what this map presents is something that goes further than an online checklist, as it enables the user to engage with the process. Therefore this is more informative than simple online information resource.

Tom: did you find the map straightforward to use when you worked your way through it?

B1 [redacted]: yes, I thought it was very straightforward, it looks mind-boggling when you first see it, but once you start working your way through it, I thought it was very clear. I think the tendency to IS to try and do more and more in application, but I thought that what you did and managed to do was very clear and very concise, and you shouldn't spoil that. It is hard to get school companies to work on these things, as I think from the offset they assume they have better things to do.

Tom: have you seen anything like this before Jane?

B1 [redacted]: now I haven't, that's why was so interested in it. Much of the guidance on sustainability tends to be in droves of literature, with which SMEs don't have time to read, let alone understand. I think you are developing something which is potentially very useful.

PARTICIPANT B1

PROCESS MAPPING OF IMPACT REDUCTION - FEEDBACK

1. In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?

Re-use & closed loop section jumps to the conclusion that they are preferable to one trip. That's not true. The environmental & financial cost of returning & cleaning can outweigh any potential advantage.

2. In what ways has this process mapping tool informed your understanding of:
   a. *Assessing an NPD processes in terms of sustainability*

Nice comprehensive approach

   b. *The development of your personal objectives towards potential new practices*

N/A

3. Where has the map demonstrated within your company the potential for:
   a. *Environmental Impact reduction within NPD*

N/A

   b. *Cost reduction within NPD*

N/A

[redacted]

4. How do you see this mapping process being used to develop competitive advantage?

N/A

5. What benefits did you find as a result of this review being **visual** rather than purely textual?

Very helpful because it's concise and complete

6. In carrying out this review, did you find any opportunities for improvement of the mapping tool?

No. I liked the flow.

Name: [redacted] Date: 9/4/13 Signature: [redacted]

THANK YOU KINDLY FOR YOUR HELP!

Hi Tom,

PARTICIPANT C1

Many apologies: I'm in the middle of a major review of services so somewhat tied up! However no excuse for not getting back to you.

C1

My comments would be:

1. I really like the approach, the simple map approach is once you get your eye in very easy to use. There is probably scope if this were to go into use to get a designer to look at the layout: this is very 'engineer' but needs to be reworked (as initially feels overpowering) to feel more like a flow diagram in a 'popular' management book.

2 > 3 MISSED QUESTION

2. For most SMEs cost is the key: cost reduction if possible, demonstration that changes are at least cost neutral vital. This is because cost is everything to their customers (ultimately the major retailers environmental commitments are just "greenwash").

4 3. Cost saving will be the way it is used for competitive advantage.

5 4. Time, material, etc. cost and waste will resonate; not sure that carbon will (SMEs are unlikely to have EU Carbon budgets).

6 5. Why aren't there engagement status boxes for part 7- working with suppliers?

7 6. For v2 I'd look to incorporate boxes where the SME (or the consultant, regulator advising) can quantify the time (hrs and £), cost (£) and waste (kg/m and £). This will both show the benefits in total and help focus activity on where the business will make the biggest saving

8 7. For v2 I'd look at the idea of ancillary benefits, e.g. replaced transit packaging can be branded.

9 8. I'd love a tool like this to go through the processes with businesses: they save money, I get a tick in the "compliant businesses" column, everyone a winner!

✓ C

I'm free 9:00 – 12:00 and 14:00 – 16:00 on Friday 11/10/13.

JUST BECOMES A LIST OF RECOMENDATIONS + IMPROVEMENTS

Regards,

Hi Tom,

Thanks for sharing this with me – sorry for my delay in getting back to you.

I like the alternative way you decided to breakdown the SME businesses – I've always thought that the current official model lacked sufficient discrimination to really understand what are the needs / drivers / barriers for different sized businesses.

Your findings chime with those that WYTSS has found in discussing packaging with businesses.

As a practitioner I would find it useful to have these findings summarised in a single table (or possibly two – 'Barriers' and 'Opportunities') with the barriers and opportunities listed with columns for each of your findings. This is both easier to use and can guide interventions: obviously cost is always an issue but being meaningful for the largest number of stakeholders is also a very important consideration, so seeing the same barrier across all SMEs or the same opportunity in a simple read-across table is very helpful.

Regards,

[redacted] PARTICIPANT C2

Tom: Lisa, you mentioned that you were involved in a three-year project with SMEs which provided documentation for them to assess their packaging, what happened to it and where did it go?

C2: [redacted]: the project was in relation to the packaging regulations, and essential requirements for small businesses and a team of three of us were put onto the project for three years. This project was funded by the waste section Council between 2008 and 2011, but due to massive budget cuts in 2011 the project was ended. The team was then broken up and we have since continued regular trading standards roles which mainly revolve around the quality of the product and customer complaints.

Tom: even though there was value in the method which you are using, the council not see any reason to continue the project and finding further funding for it?

C2 [redacted]a: even though the project was split up and we went back to our normal positions within trading standards, the regulations still remain which aim to deal with this problem, so in essence the regulations take that role on will stop in terms of prioritising trading standards work now, we just don't do any more. That's the thing, we weren't getting any complaints about it so it was never a point of focus. It was mainly from the waste Department I can see the value in reducing amount of packaging going to landfill so they wanted us to enforce the legislation, so that they weren't having as much waste to get rid of, but to be honest the majority of complaints we got were more in relation to other companies outside of Lincolnshire where packaging enters the waste stream from other organisations.

Tom: do you think that SMEs still needed something that helps them digest the areas of sustainability and best practice for packaging, and do you think that something that is more visual can help them do that?

C2 [redacted]a: yes, the starting point for us would be firstly where we get a complaint in relation to a product being over packaged and then we can request a technical file from the SME as part of the legislation. Now if you go to some of the larger companies they know what technical files are, but the legislation does not lay down what that technical file has to contain, so some of the companies which were more on the ball with this were okay, but smaller SMEs were saying: we wanted to bring the product to market and we didn't really think about the packaging we were putting around it, it was just a case of putting packaging there to get it to market without any damage or deterioration over that period of time. So then they were asking: what should our technical file contain? So we were then involved with taking them through that process with them, asking them questions such as: so what is your product what are your reasons for the particular packaging you want on it? We would usually try and develop some checklists ourselves [redacted]

that we could use with them to help them understand. So as a starting point it really is just a matter of posing some questions to them, just to make them think about what they are doing. Even if they came to the conclusion at the end of the discussion that packaging that they had is the packaging that they wanted and was right for the product then so be it, but they needed to have gone through that thought process, as the majority of the encountered hadn't. So I do think that there is a need. We don't do much more this work now and since the project ended three years ago, I really can't imagine that the market out there is change that much at all, so I see that there really is a need for it.

Tom: it really is almost like a prompting method isn't it, you think this match could be useful in the context of using it as a prompting talk in conjunction with other information, such as a brochure, where the map indicates areas of interest which they can then investigate in further detail if required?

C2 yes, it really is just about helping them pose the right questions. You know, "we have always used this packaging and we have never really thought about it any differently, but until you started to question on it, we would still be using it now ". It sometimes takes a regulator like ourselves to challenge these things with them, and get them to consider things, get them to realise that there are other opportunities for them. If companies were to address this kind of thing right from the early product development stage, they need something which just helps to get their cogs moving round and thinking differently, why are we doing this, almost self challenging themselves before bringing the product to market. I mean we usually found when we worked with organisations that through the process of asking questions, eventually we could save them some money, or some resources, awesome time etc, and therefore at the end not only were they compliant, but they also realised that actually they could save himself something through the process too.

Tom: so basically you were challenging them through a process getting in to think differently prompting them, but at the end getting them to realise that there were benefits to do so.

C2 yes certainly, with the packaging we were in a position to challenge them and help them to see benefit, and get them to challenge themselves and asking those questions, because there is a need out there, or for some sort of guidance whether it be with flowcharts or whatever.

Tom: do you find that when you using flowcharts with the SMEs, and putting information in a format which was engageable which gets people to discuss and work with the information in a tangible manner, where to see the value with that?

Lisa: I do yes, personally I'm more engaged with something which I can follow through a process and prompt questions along the way to help me guide myself, with some of the documentation there is so much information that you end up reading it and possibly not remembering some of the main value inside it.

Tom: how do you see the effectiveness of the system which essentially works between the SME and the regulator as a point of interaction for both sides, as a common ground with which information can be updated and accessed as a way of reaching out to small businesses from the regulator.

Lisa: they could be merit with having something which goes on the Internet for training standards, which wants access to can point or refer them to their local authorities training standards for more detailed information, I do think this would be worthwhile at the starting point for them. A lot of trading standards departments don't usually do this kind of work and we were very fortunate to be engage with the project initially for those three years, and other trading standards organisations from different localities were more than happy for us to intervene and work with organisations within those areas, as we had the specialisms to do so on their behalf. But this doesn't normally happen with trading standards, as usually wherever an organisation is based their head office or local authority will normally deal with their problem within their region, but for online system which deals with the generic questions such as what are the legislations who they apply to etc, this is generally across-the-board, and then they could be directed to their local trading standards offices if further information was needed, so that could certainly going to any online toolkit.

FURTHER RESEARCH

PARTICIPANT C2

PROCESS MAPPING OF IMPACT REDUCTION - FEEDBACK

1. In what ways do you feel the process mapping tool can facilitate understanding for SMEs in relation to sustainable activities, Regulations, and potential benefits?

See over. TRANSCRIPT.

a visual process

b inform

c ANSWERS HERE

2. In what ways do you think the understanding of this tool can inform:
   a. *Assessing NPD process for SMEs against sustainability*

DON'T THINK THESE TWO ARE RELEVENT NOW AS THEY ARE ANSWERED IN Q1 too.

   b. *The development of sustainable objectives for SMEs*

3. Where do you feel the map demonstrates the most potential for:
   a. *Impact reduction within NPD*

   b. *Cost reduction within NPD*

4. How do you see this mapping process being used to develop competitive advantage?

This is not something I am able to comment on.

5. What benefits did you find as a result of this review being visual rather than purely textual?

In my personal opinion a visual rather than text would assist. Questions used as prompts help the area's to be covered be considered. Assists with consistency of approach.

6. In what ways could you see this method being used as a common template between the regulator and the SMEs, to disseminate and digest requirements and obligations?

Again, from my experience of working with businesses towards compliance with the Packaging (Essential Requirements) Regs a template / checklist with common questions would assist in any dialogue

7. In carrying out this review, did you find any opportunities for improvement of the mapping tool?

At first, the tool looks quite complex but once you work through the text and take it stage by stage. It does make sense.

THANK YOU KINDLY FOR YOUR HELP

PARTICIPANT D1

PROCESS MAPPING OF IMPACT REDUCTION - FEEDBACK

1. In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?

It creates a systematic approach to integrating green into CPD

2. In what ways has this process mapping tool informed your understanding of:

   a. *Assessing an NPD processes in terms of sustainability*

It really helps — P.D love process, the problem with green is that it can be a bit woolly or just EMS. This process ~~steps~~ provides a stepped approach to implement green in a creative role.

   b. *The development of your personal objectives towards potential new practices*

N/A — but I'm sure it helps in CPD. ✓

3. Where has the map demonstrated within your company the potential for:

   a. *Environmental Impact reduction within NPD*

Throughout the process — it helps ask the right questions at the design phase

   b. *Cost reduction within NPD*

green should always save money

4. How do you see this mapping process being used to develop competitive advantage?

cost savings, better product features, wider commitment

5. What benefits did you find as a result of this review being **visual** rather than purely textual?

fits the P.D + design user

6. In carrying out this review, did you find any opportunities for improvement of the mapping tool?

Some worked examples would be good - ☺

D1 Name: [redacted] Date: 15/11 Signature: [redacted] THANK YOU KINDLY FOR YOUR HELP!

PARTICIPANT D2

PROCESS MAPPING OF IMPACT REDUCTION - FEEDBACK – FROM A PACK AND BRANDED PACKAGING DESIGN PERSFECTIVE

1. In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?

IF WE ARE ASKED TO CONSULT WITH A CLIENT THIS WILL BE AN EXCELLENT TOOL.

2. In what ways has this process mapping tool informed your understanding of:
   a. *Assessing an NPD processes in terms of sustainability* TO A POINT.
   THIS PROCESS WORKS FOR FUNCTIONAL PRODUCTS, MOST BRANDED PACKS ARE NOT A CONVENTIONAL SHAPE, CONTAIN NON ECO INGREDIENTS OR ARE MANUFACTURED IN CHINA TO KEEP COSTS TO A MINIMUM.
   b. *The development of your personal objectives towards potential new practices*

– NA –

3. Where has the map demonstrated within your company the potential for:
   a. *Environmental Impact reduction within NPD*

   b. *Cost reduction within NPD*

4. How do you see this mapping process being used to develop competitive advantage?
IT MAY GO SOME WAY TO REDUCE COSTS
IT WILL QUALIFY ON PACK ENVIRONMENTAL CREDENTIALS AND ICONS.

5. What benefits did you find as a result of this review being **visual** rather than purely textual?
AS A VISUAL PERSON A MAP IS PERFECT
PLUS I GOT TO OXFORD CIRCUS ON TIME.
ITS EXTREMELY COMPLEX AND WOULD BE EASIER TO NAVIGATE

6. In carrying out this review, did you find any opportunities for improvement of the mapping tool?
AS A CONTEXTUAL WEB SITE

NO

D2

Name: [redacted] Date: 21.6.13 Signature:

THANK YOU KINDLY FOR YOUR HELP!

PARTICIPANT D2

D2. Hi Tom,

Yes I have them - I'm sorry I haven't been in touch I've been up against it - I've had a glance and whilst it initially blew my mind, I can see how it works but need to sit down and look at the detail which I promise I'll do this week and get back to you by Friday.

I'll send Adam his copy too.

Cheers

D2

D2 Hi Tom,

I've studied your map over the last two days and have sent my feedback in the post.

Top line:

MORE REFINEMENT OF KEY FACTORS NEEDED

I think it's a great tool for business to follow. ✓

I think the reality will be that there will only be a percentage of the criteria achievable by organisations.

There should be mention of balancing commercially effective sales and profit driven design criteria against functional cost and environmental impact. EQUITMENT COST PERFORMANCE WORKS

What I mean is a branded packs purpose is to drive sales and therefore profit through consumer attracting product, packaging and container.

Generally this involves sourcing containers from China because they are cheaper than UK, paper, printing and varnishes that may only pay lip service to environment.

Also the distribution and logistics systems employed by the multiples may not entirely be conducive to reducing food miles - bring back the canal system.

I think it's better as a map - words would become jargon and difficult for average business owners to digest (Excluding Adam who has a laser brain the size of a planet) ✓

However, I think this is a great tool to be employed at the genesis of a product, even if the participating organisation can only implement some of the ideas here, it's a start. ✓

Hope this helps

kind regards

D2. ☺

PARTICIPANT D3

PROCESS MAPPING OF IMPACT REDUCTION - FEEDBACK

1. In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?

- Can be long + complex packaging supply chain ✓

- Various ways in approach to tackle issues ✓

2. In what ways has this process mapping tool informed your understanding of:
   a. Assessing an NPD processes in terms of sustainability

- As above

   b. The development of your personal objectives towards potential new practices

- Very much depends what pressure is being driven by the supply chain

- Main driver is cost, which can make a lot of packaging unsuitable, as price is "....." issues are secondary.

3. Where has the map demonstrated within your company the potential for:
   a. Environmental impact reduction within NPD

- Difficult to quantify. The tool doesn't allow for this.

- Yes, it implies cost savings, but how much + what are the priorities?

   b. Cost reduction within NPD

- As above

4. How do you see this mapping process being used to develop competitive advantage?

- Not sure SMT's would use in current format. Perhaps if a "....." tool could be developed, which included costing models based on "....." "....." "....." benchmarks from similar sectors.

5. What benefits did you find as a result of this review being visual rather than purely textual?

- On first impression, the tool looks complex, but is fairly easy to follow once you take the plunge. There would need to be more quantification of potential savings etc, for me to use in the future.

6. In carrying out this review, did you find any opportunities for improvement of the mapping tool?

- Tool is focused on 'environmental' performance issues, rather than social and financial elements of sustainability.

- Its a very academic tool, im not sure businesses would use it in its current format. ✓

- The above questions could be more balanced - driven towards getting a positive response (only)

Name: [redacted] Date: 23/04/13 Signature: [redacted]

THANK YOU KINDLY FOR YOUR HELP!

D3

Chris Wilson:

Tom: the intention of using the framework is to create a prompting tool which helps SME organisations ask more informative questions in relation to sustainability, have you feel the map represents this?

yes I think it does. It was a little bit frightening to begin with, but once I got into it it was quite straightforward and easy-to-use. As an improvement, it would most likely need something indicative of the actual cost saving with some data which could be put into it to give an actual result, as some additional context to include to give it that the next step. In the sense of being able to quantify the benefits to give it that additional bit of intellect.

~~Tom: (originality in my Ph.D. 40 minutes) Yimin: (56 gaps. But we found what gaps are currently not being filled chi~~ not just putting stuff in) ~~All the areas included are areas currently lacking in SME best practice[HL1410 response to survey, a limitation Tom.~~

PARTICIPANT D3

PROCESS MAPPING OF IMPACT REDUCTION - FEEDBACK

1. In what ways has the process mapping tool facilitated understanding towards your company's interrelation with sustainable activities, and their benefits?

- Can be long + complex perhaps supply chain
- Various ways / approaches to tackle issues

2. In what ways has this process mapping tool informed your understanding of:
   a. *Assessing an NPD processes in terms of sustainability*

As above

   b. *The development of your personal objectives towards potential new practices*

- Very much depends what pressure is being driven by the supply chain
- Mat does is cost, what re-make = if packaging unsustainable as price is rising + other issues are occurring

3. Where has the map demonstrated within your company the potential for:
   a. *Environmental Impact reduction within NPD*

Difficult to quantify. The tool doesn't show be this. Yes, it implies cost savings, but how much + what are the priorities?

   b. *Cost reduction within NPD*

As above.

4. How do you see this mapping process being used to develop competitive advantage?

Not sure SMEs would use a carbon brand. Perhaps, if a g'aise tool could be developed, which included ranking models based on actual cost the benchmarks from ~~other~~ similar sectors.

5. What benefits did you find as a result of this review being **visual** rather than purely textual?

On first impression, the tool looks complex, but is fairly easy to follow once you look the glossary. There would need to be more qualification of potential savings etc for me to use in future.

6. In carrying out this review, did you find any opportunities for improvement of the mapping tool?

Tool is focused on 'environmental' issues, rather than social + financial elements of sustainability.

- It's a very academic tool, I'm not sure businesses would use it in its current format
- The above questions could be more balanced - always towards getting a positive response (only)

Name: Chris Wilson Date: 08/04/13 Signature: C Wilson

THANK YOU KINDLY FOR YOUR HELP!

PARTICIPANT E1

hi Tom

I've got it and had an initial look through it.

I thought the layout was good and well thought through.

my "critical eye" makes the following comments.

why nothing about disassembly? surely ease of recycling of the product itself is important.

you have imposed a rigid structure on the development process that is probably not followed by many sme's (ITS GENERIC) IF NOT, HOW ELSE? NO NEED?

the diagram gives a good understanding of the process that should be followed but leaves a lot of manual spadework to the user. ITS NEEDED TO ENABLE NO TIME

the assessment is very subjective and some measures of costs and a weighted scoring system would highlight where priorities lie

I would want your system to tell me where I should concentrate my efforts and the savings I would make because of that. ? IT DOES IF ITS FILLED CORRECTLY!?

I'm not back in the uk till may 4th

I'm happy to meet up and discuss further after that.

I think what you've done so far is good. I'm hopefully just making you think how to make it more useful in the big bad business world !

regards

Ms E1

SME / BUSY / HARD TO GET CONSISTENT + CONSIDERED FEEDBACK

Tom...sorry. Have been away. I've been useless. My apologies.

PARTICIPANT E2

Looking at the map it is clear you're a very clever guy. I suppose my main question to you would be how useful would it be in the real world of business? It's not a criticism, it's a challenge. Business is common sense on the most part with the odd inspiration of genius that creates great business' and more flashes of inspiration sustain them.

What I see at a very topline level with your map is a document mapping the process flow as described by the Green Circle in the Instructions for Use. You are laying out common sense principles covering off every element along the way.

As a process flow document ticking off what a Consultant/Employee should work to within a framework for advising, it appears very good with sensible logical steps attached. Does this type of document already exist? I'm assuming not. Why don't you take the process map and use it as a calling card to advise companies on their strategy surrounding Environmental Impact Reduction and Best Practice? This is your document and your intellectual property I am assuming?

There must be a lot of factories in the UK and abroad needing this kind of advice? Take a smallish flat fee, and take a percentage of the saving they make by adopting any methods you recommend (or not as the case may be). Apologies, but I'm jumping ahead here and it may well be uncalled for.

If you want to talk some more around this am happy to do so. I don't own factories and the factories I work with would likely not need your services, but I may (and I repeat may) be able to put you in contact with some people who would be in the field your document would be relevant to and would certainly consider the document if nothing else. Something or nothing may come of it.

You asked me to give you a view from a business person's perspective. That I am doing.

LETS LOST HERE.

Kind Regards

E2 [redacted]

CEO

[redacted]

SME / BUSY.
HARD TO GET CONSISTANT + CONSIDERED FEEDBACK.

Additionally provided is an example of a post-evaluation phone transcription which was used to further define areas for process mapping improvement and areas of further research.

TW: do you think that SMEs still needed something that helps them digest the areas of sustainability and best practice for packaging, and do you think that something that is more visual can help them do that?

LF: yes, the starting point for us would be firstly where we get a complaint in relation to a product being over packaged and then we can request a technical file from the SME as part of the legislation. Now if you go to some of the larger companies they know what technical files are, but the legislation does not lay down what that technical file has to contain, so some of the companies which were more on the ball with this were okay, but smaller SMEs were not. So then they were asking: what should our technical file contain? So, we were then involved with taking them through that process with them, asking them questions such as: so what is your product, what are your reasons for the particular packaging you want on it?

We would usually try and develop some checklists ourselves that we could use with them to help them understand. So as a starting point it really is just a matter of posing some questions to them, just to make them think about what they are doing. Even if they came to the conclusion at the end of the discussion that packaging that they had is the packaging that they wanted and was right for the product then so be it, but they needed to have gone through that thought process, as the majority hadn't. So I do think that there is a need. We don't do much more of this work now and since the project ended three years ago, I really can't imagine that the market out there has changed that much at all, so I see that there really is a need for it.

TW: it really is almost like a prompting method isn't it, do you think this method could be useful in the context of using it as a prompting tool in conjunction with other information, such as a brochure, where the map indicates areas of interest which they can then investigate in further detail if required?

LF: yes, it really is just about helping them pose the right questions. You know, "we have always used this packaging and we have never really thought about it any differently, but until you started to question on it, we would still be using it now". It sometimes takes a regulator like ourselves to challenge these things with them, and get them to consider things, get them to realise that there are

other opportunities for them. If companies were to address this kind of thing right from the early product development stage, they need something which just helps to get their cogs moving round and thinking differently, why are we doing this, almost self challenging themselves before bringing the product to market. I mean we usually found when we worked with organisations that through the process of asking questions, eventually we could save them some money, or some resources, or some time etc, and therefore at the end not only were they compliant, but they also realised that actually they could save something through the process too.

TW: so basically you were challenging them through a process getting them to think differently, prompting them, but at the end getting them to realise that there were benefits to do so.

LF: yes certainly, with the packaging we were in a position to challenge them and help them to see benefit, and get them to challenge themselves by asking those questions, because there is a need out there, or for some sort of guidance whether it be with flowcharts or whatever.

TW: do you find that when using flowcharts with the SMEs, putting information in a format which was engage able gets SMEs to discuss and work with the information in a tangible manner?

LF: I do yes, personally I'm more engaged with something which I can follow through a process and prompt questions along the way to help me guide myself, with some of the documentation there is so much information that you end up reading it and possibly not remembering some of the main value inside it.

TW: how do you see the effectiveness of the system which essentially works between the SME and the regulator as a point of interaction for both sides, as a common ground with which information can be updated and accessed as a way of reaching out to small businesses from the regulator.

LF: there could be merit with having something which goes on the Internet for training standards, which wants access to can point or refer them to their local authorities training standards for more detailed information. I do think this would be worthwhile at the starting point for them. A lot of trading standards departments don't usually do this kind of work and we were very fortunate to have been engaged previously with the project initially for those three years, and other trading standards organisations from different localities were more than happy for us to intervene and work with organisations within those areas, as we had the specialisms to do so on their behalf. But this doesn't normally happen with trading standards, as usually wherever an organisation is based their head office

or local authority will normally deal with their problem within their region, but for online system which deals with the generic questions such as what are the legislations who they apply to etc, this is generally across-the-board, and then they could be directed to their local trading standards offices if further information was needed, so that could certainly work as an online toolkit.

12: PUBLICATIONS

Listed below are the current publications which are associated with this current thesis.

1) Woods., T.M., Cheung., W.M., Hilton, K, Penlington, R, (2015), "A Visual Process Map for Environmental Impact Reduction during New Product Development in Small and Medium-sized Manufacturing Enterprises", Journal of Cleaner Production, (revised version submitted)

2) Woods., T.M., Cheung., W.M., Hilton, K, Penlington, R, (2015), Environmental Impact Reduction for Small and Medium-sized Manufacturing Enterprises in New Product Development, International Conference on Sustainable Design and Manufacturing, Seville, Spain, 12-14 April 2015.

3) Woods, T, Cheung, W.M., Hilton, K, Penlington, R, (2011), "Long Term Sustainable Product Development at the Packaging Sector", International Conference on Manufacturing Research (ICMR2011), Glasgow Caledonian University, Glasgow, UK, Pages 180-186, 6th-8th September 2011.